SC200L-EM

Hardware Design

Smart module series

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Status：Controlled Documents

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About the Document

Revision History

Revision	Date	Author	Description
1.0	2020-9-21	Jeffrey/Andy	Initial

Contents

1 Introduction

This document defines the SC200L module and its air interfaces and hardware interfaces which are connected with customers' application.

1.1. Safety Information

The following safety precautions must be observed during all phases of operation, such as usage, service or repair of any cellular terminal or mobile incorporating SC200L module. Manufacturers of the cellular terminal should send the following safety information to users and operating personnel, and incorporate these guidelines into all manuals supplied with the product. If not so, Quectel assumes no liability for customers' failure to comply with these precautions.

	Full attention must be given to driving at all times in order to reduce the risk of an accident. Using a mobile while driving (even with a handsfree kit) causes distraction and can lead to an accident. Please comply with laws and regulations restricting the use of wireless devices while driving.
	Switch off the cellular terminal or mobile before boarding an aircraft. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. If the device offers an Airplane Mode, then it should be enabled prior to boarding an aircraft. Please consult the airline staff for more restrictions on the use of wireless devices on boarding the aircraft.
	Wireless devices may cause interference on sensitive medical equipment, so please be aware of the restrictions on the use of wireless devices when in hospitals, clinics or other healthcare facilities.
	Cellular terminals or mobiles operating over radio signals and cellular network cannot be guaranteed to connect in all possible conditions (for example, with unpaid bills or with an invalid (U)SIM card). When emergent help is needed in such conditions, please remember using emergency call. In order to make or receive a call, the cellular terminal or mobile must be switched on in a service area with adequate cellular signal strength.

	The cellular terminal or mobile contains a transmitter and receiver. When it is ON, it receives and transmits radio frequency signals. RF interference can occur if it is used close to TV set, radio, computer or other electric equipment.
	In locations with potentially explosive atmospheres, obey all posted signs to turn off wireless devices such as your phone or other cellular terminals. Areas with potentially explosive atmospheres include fuelling areas, below decks on boats, fuel or chemical transfer or storage facilities, areas where the air contains chemicals or particles such as grain, dust or metal powders, etc.

2 Product Concept

2.1. General Description

SC200L is a series of 4G Smart LTE module based on UNISOC platform and Android operating system, and provides industrial grade performance. Its general features are listed below:

- Support LTE-FDD, LTE-TDD, WCDMA, EDGE, GSM and GPRS coverage.
- Support short-range wireless communication via Wi-Fi 802.11a/b/g/n and BT4.2 LE.
- Integrate GPS/GLONASS/BeiDou satellite positioning systems.
- Support multiple audio and video codecs.
- Built-in high performance Mail-T820 graphics processing unit.
- Provide multiple audio and video input/output interfaces as well as abundant GPIO interfaces.

SC200L module is available in three variants: SC200L-CE, SC200L-EM, SC200L-WF.

Table 1：SC200L-EM frequency bands

Mode	Frequency band
LTE-FDD	B1/B2/B3/B5/B7/B8/B20/B28
LTE-TDD	B38/B39/B40/B41(200 MHz)
WCDMA	B1/B2/B5/B8
GSM	850/900/1800/1900 MHz
Wi-Fi 802.11b/g/n	CE: 2412-2472 MHz FCC: 2412-2462 MHz
BT 4.2 LE	2402~2480 MHz
GNSS	GPS: 1575.42 ±1.023 MHz GLONASS: 1597.5~1605.8 MHz BeiDou: 1561.098 ±2.046 MHz

2.2. Evaluation Board

To help customers design and test applications with Quectel SC200L modules, Quectel supplies an evaluation kit, which includes an evaluation board, a USB to RS232 converter cable, a USB T data cable, a power adapter, an earphone and antennas. For details, please refer the ***document [1]***

3 Application Interfaces

3.1. General Description

SC200L is an SMD type module with 146 LCC pins and 128 LGA pins. The following chapters provide the detailed description of pins/interfaces listed below.

- Power supply
- USB interface
- UART interfaces
- (U)SIM interfaces
- GPIO interfaces
- I2C interface
- SPI interfaces
- ADC interfaces
- LCM interfaces
- Touch panel interface
- Camera interfaces
- Sensor interfaces
- Audio interfaces
- Emergency download interface

3.2. Pin Assignment

The following figure shows the pin assignment of SC200Lmodule.

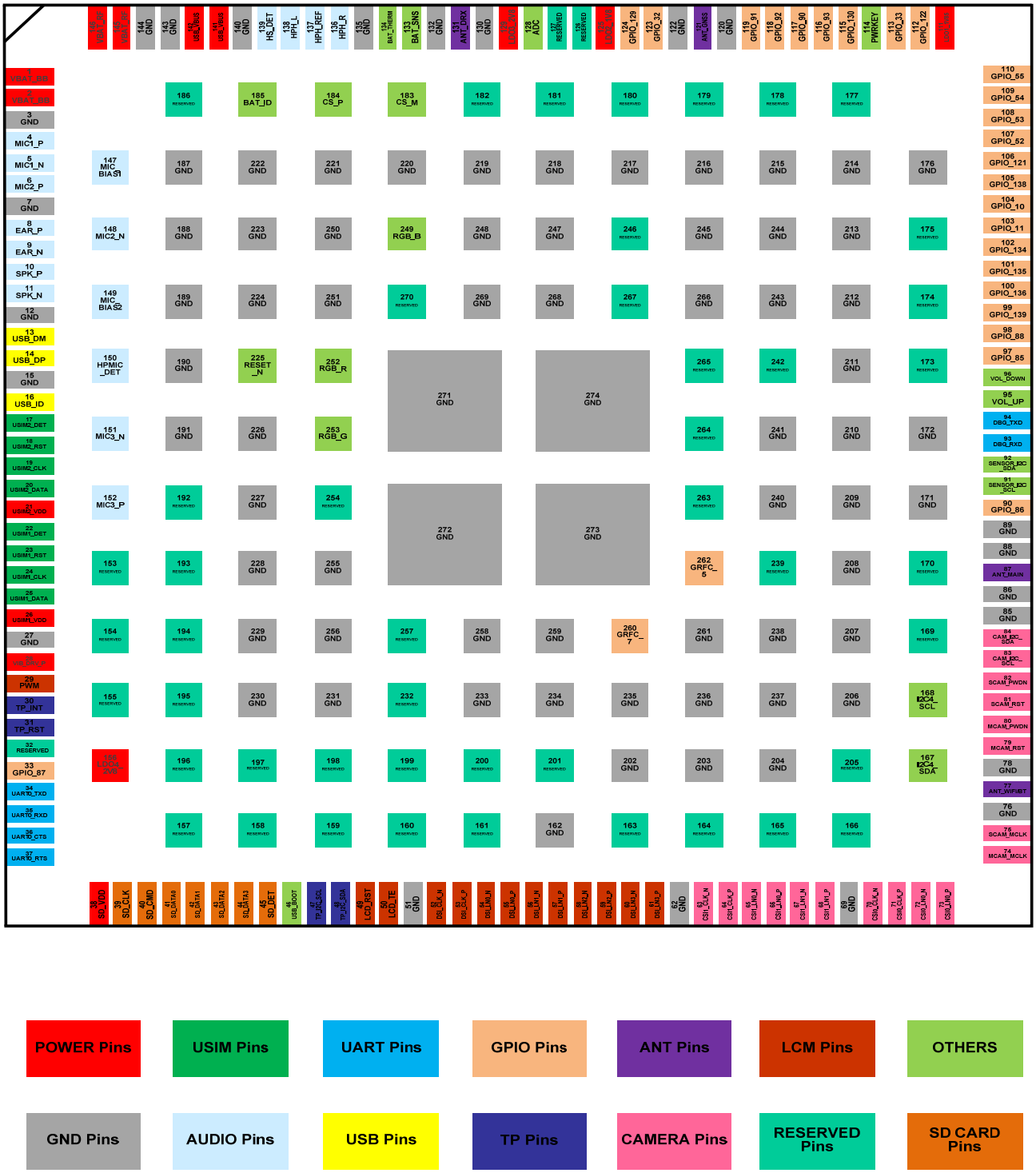


Figure 1: Pin Assignment (Top View)

3.3. Pin Description

The following tables show the SC200L's pin definition.

Table 4: I/O Parameters Definition

Type	Description
AI	Analog input
AO	Analog output
DI	Digital input
DO	Digital output
IO	Bidirectional
OD	Open drain
PI	Power input
PO	Power output

The following tables show the SC200L's pin definition and electrical characteristics.

Table 5: Pin Description

Power supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VBAT_BB	1, 2	PI/PO	Power supply for module's baseband part	Vmax=4.2V Vmin=3.55V Vnorm=3.8V	It must be provided with sufficient current up to 3.0A.
VBAT_RF	145, 146	PI	Power supply for module's RF part.	Vmax = 4.20 V Vmin = 3.50 V Vnorm = 3.80 V	It is suggested to use a TVS for external circuit.
LDO1_1V85	111	PO	1.85V output power supply	Vnorm=1.85V IOmax=100mA	Power supply for external GPIO's pull up circuits and level shift circuit.

LDO2_1V8	125	PO	1.8V output power supply	Vnorm = 1.80 V $I_O$max = 500 mA	Power supply for sensors, cameras, and I2C pull-up circuits.
LDO4_2V8	156	PO	2.80V output power supply	Vnorm = 2.80 V $I_O$max = 200 mA	Power supply for LCD, touch screen and sensors
LDO3_2V8	129	PO	输出 2.80 V	Vnorm = 2.80 V $I_O$max = 150 mA	Power supply for camera AVDD and AFVDD。
GND					
Pin Name	**Pin No.**				
GND	3、7、12、15、27、51、62、69、76、78、85、86、88、89、120、122、130、132、135、140、143、144、162、171、172、176、187、188、189、190、191、202、203、204、206、207、208、209、210、211、212、213、214、215、216、217、218、219、220、221、222、223、224、226、227、228、229、230、231、233、234、235、236、237、238、240、241、243、244、245、247、248、250、251、255、256、258、259、261、266、268、269、271、272、273、274				
Audio Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
MIC1_P	4	AI	Microphone input for channel 1 (+)		
MIC1_N	5	AI	Microphone input for channel 1 (-)		
MIC2_P	6	AI	icrophone input for headset (+)		
MIC2_N	148	AI	icrophone input for headset (-)		
EAR_P	8	AO	Earpiece output (+)		
EAR_N	9	AO	Earpiece output (-)		
SPK_P	10	AO	Speaker output (+)		
SPK_N	11	AO	Speaker output (-)		
HPH_R	136	AO	Headphone right channel output		
HPH_REF	137	AO	Headphone reference ground		No need to be grounded.

HPH_L	138	AO	Headphone left channel output		
HS_DET	139	AI	Headset insertion detection		The default is high.
HPMIC_DET	150	AI	Headphone microphone detection		
MIC_BIAS1	147	PO	Microphone bias1 voltage	V_O = 2.20~3.00 V Vnorm = 2.50 V	
MIC3_P	152	AI	Microphone input for secondary microphone (+)		
MIC3_N	151	AI	Microphone input for secondary microphone (-)		
MIC_BIAS2	149	PO	Microphone bias2 voltage	V_O = 2.20~3.00 V Vnorm = 2.80 V	
USB Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
USB_VBUS	141、142	PI	USB power supply	Vmax=9.2V Vmin=4.5V Vnorm=5.00V	Used for USB 5V power input and USB detection.
USB_DM	13	AI/AO	USB differential data bus (-)	USB 2.0 standard compliant.	90Ω differential impedance.
USB_DP	14	AI/AO	USB differential data bus (+)		
USB_ID	16	DI	USB ID detection of the input		High level by default.
(U)SIM Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
USIM2_DET	17	DI	(U)SIM2 card plug detection	V_{IL}max=0.48V V_{IH}min=1.39V	Active low. If it is not used, keep it open. This function is turned on by default. It can be used as ordinary GPIO.

USIM2_RST	18	DO	(U)SIM2 card reset signal	V_{OL}max = 0.1 × USIM2_VDD V_{OH}min = 0.9 × USIM2_VDD	It cannot be multiplexed into a Generic GPIOs.
USIM2_CLK	19	DO	(U)SIM2 card clock signal	V_{OL}max = 0.1 × USIM2_VDD V_{OH}min = 0.9 × USIM2_VDD	It cannot be multiplexed into a Generic GPIOs.
USIM2_DATA	20	IO	(U)SIM2 card data signal	V_{IL}max = 0.3 × USIM2_VDD V_{IH}min = 0.7 × USIM2_VDD V_{OL}max = 0.1 × USIM2_VDD V_{OH}min = 0.9 × USIM2_VDD	It cannot be multiplexed into a Generic GPIOs.
USIM2_VDD	21	PO	(U)SIM2 card power supply	**1.80 V (U)SIM:** Vmax = 1.85 V Vmin = 1.75 V **2.95 V (U)SIM:** Vmax = 3.1 V Vmin = 2.90 V	Either 1.8V or 2.95V (U)SIM card is supported.
USIM1_DET	22	DI	U)SIM1 card plug detection	V_{IL}max = 0.48 V V_{IH}min = 1.39 V	Active low. If it is not used, keep it open. This function is turned on by default. It can be used as ordinary GPIO.
USIM1_RST	23	DO	(U)SIM1 card reset signal	V_{OL}max = 0.1 × USIM1_VDD V_{OH}min = 0.9 × USIM1_VDD	It cannot be multiplexed into a Generic GPIOs.
USIM1_CLK	24	DO	(U)SIM1 card clock signal	V_{OL}max = 0.1 × USIM1_VDD V_{OH}min = 0.9 × USIM1_VDD	It cannot be multiplexed into a Generic GPIOs.

USIM1_DATA	25	IO	(U)SIM1 card data signal	V_{IL}max = 0.3 × USIM1_VDD V_{IH}min = 0.7 × USIM1_VDD V_{OL}max = 0.1 × USIM1_VDD V_{OH}min = 0.9 × USIM1_VDD	It cannot be multiplexed into a Generic GPIOs.
USIM1_VDD	26	PO	(U)SIM1 card power supply	**1.80 V (U)SIM:** Vmax = 1.85 V Vmin = 1.75 V **2.95 V (U)SIM:** Vmax = 3.1 V Vmin = 2.90 V	Either 1.8V or 2.95V (U)SIM card is supported 。
UART Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
UART0_TXD	34	DO	UART0 transmit data	V_{OL}max = 0.20 V V_{OH}min = 1.46 V	1.85V power domain, If it is not used, keep it open.
UART0_RXD	35	DI	UART0 receive data	V_{IL}max = 0.48 V V_{IH}min = 1.39 V	
UART0_CTS	36	DI	UART0 clear to send	V_{IL}max = 0.48 V V_{IH}min = 1.39 V	
UART0_RTS	37	DO	UART0 request to send	V_{OL}max = 0.20 V V_{OH}min = 1.46 V	
DBG_RXD	93	DI	UART1 receive data.Debug port by default.	V_{IL}max = 0.48 V V_{IH}min = 1.39 V	
DBG_TXD	94	DO	UART1 transmit data.Debug port by default.	V_{OL}max = 0.20 V V_{OH}min = 1.46 V	
SD Card Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
SD_VDD	38	PO	3.00V output power supply	Vnorm = 3.00 V $I_O$max = 400 mA	Power supply for SD.
SD_CLK	39	DO	1.8V/2.95V output power supply	**1.8 V SD card：** V_{OL}max = 0.19 V V_{OH}min = 1.58 V **3.0 V SD card：** V_{OL}max = 0.31 V V_{OH}min = 2.61V	50 Ω single-ended impedance.

SD_CMD	40	IO	Command signal of SD card	**1.8 V SD card:** V_{IL}max = 0.53 V V_{IH}min = 1.30 V V_{OL}max = 0.19 V V_{OH}min = 1.58 V **3.0 V SD card:** V_{IL}max = 0.87 V V_{IH}min = 2.17 V V_{OL}max = 0.31 V V_{OH}min = 2.61 V	
SD_DATA0	41	IO	High speed bidirectional digital signal lines of SD card	**1.8 V SD card:** V_{IL}max = 0.53 V V_{IH}min = 1.30 V V_{OL}max = 0.19 V V_{OH}min = 1.58 V **3.0 V SD card:** V_{IL}max = 0.87 V V_{IH}min = 2.17 V V_{OL}max = 0.31 V V_{OH}min = 2.61 V	
SD_DATA1	42	IO			
SD_DATA2	43	IO			
SD_DATA3	44	IO			
SD_DET	45	DI	SD card insertion detection	V_{IL}max = 0.48 V V_{IH}min = 1.39 V	SD card insert detection signal. Active low.
Touch Panel (TP) Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
TP_INT	30	DI	Interrupt signal of TP	V_{IL}max = 0.48 V V_{IH}min = 1.39 V	1.85V power domain Can be used as ordinary GPIO.
TP_RST	31	DO	Reset signal of TP	V_{OL}max = 0.20 V V_{OH}min = 1.46 V	1.85V power domain Active low, Can be used as ordinary GPIO.
TP_I2C_SCL	47	OD	I2C clock signal of TP		1.85V power domain, Can be used as ordinary GPIO.
TP_I2C_SDA	48	OD	I2C data signal of TP		
LCM Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**

PWM	29	DO	Adjust the backlight brightness. PWM control signal.	V_{OL}max = 0.20 V V_{OH}min = 1.46 V	1.85V power domain. Can be used as ordinary GPIO.
LCD_RST	49	DO	LCD reset signal	V_{OL}max = 0.20 V V_{OH}min = 1.46 V	1.85V power domain. Can be used as ordinary GPIO.
LCD_TE	50	DI	LCD tearing effect signal	V_{IL}max = 0.48 V V_{IH}min = 1.39 V	1.85V power domain. Can be used as ordinary GPIO.
DSI_CLK_N	52	AO	MIPI DSI clock signal (-)		
DSI_CLK_P	53	AO	MIPI DSI clock signal (+)		
DSI_LN0_N	54	AO	MIPI DSI data 0 signal (-)		
DSI_LN0_P	55	AO	MIPI DSI data 0 signal (+)		
DSI_LN1_N	56	AO	MIPI DSI data 1 signal (-)		
DSI_LN1_P	57	AO	MIPI DSI data 1 signal (+)		
DSI_LN2_N	58	AO	MIPI DSI data 2 signal (-)		
DSI_LN2_P	59	AO	MIPI DSI data 2 signal (+)		
DSI_LN3_N	60	AO	MIPI DSI data 3 signal (-)		
DSI_LN3_P	61	AO	MIPI DSI data 3 signal (+)		
Camera Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
CSI1_CLK_N	63	AI	CAMERA MIPI clock signal (-)		
CSI1_CLK_P	64	AI	CAMERA MIPI clock signal (+)		
CSI1_LN0_N	65	AI	CAMERA MIPI data 0 signal (-)		
CSI1_LN0_P	66	AI	CAMERA MIPI data 0 signal (+)		
CSI1_LN1_N	67	AI	CAMERA MIPI data 1 signal (-)		

CSI1_LN1_P	68	AI	CAMERA MIPI data 1 signal (+)		
CSI0_CLK_N	70	AI	CAMERA MIPI clock signal (-)		
CSI0_CLK_P	71	AI	CAMERA MIPI clock signal (+)		
CSI0_LN0_N	72	AI	CAMERA MIPI data 0 signal (-)		
CSI0_LN0_P	73	AI	CAMERA MIPI data 0 signal (+)		
MCAM_MCLK	74	DO	Clock signal of camera	V_{OL}max = 0.20 V V_{OH}min = 1.46 V	1.85V power domain
SCAM_MCLK	75	DO	Clock signal of camera	V_{OL}max = 0.20 V V_{OH}min = 1.46 V	1.85V power domain Can be used as ordinary GPIO.
MCAM_RST	79	DO	Reset signal of camera	V_{OL}max = 0.20 V V_{OH}min = 1.46 V	
MCAM_PWDN	80	DO	Power down signal of camera	V_{OL}max = 0.20 V V_{OH}min = 1.46 V	
SCAM_RST	81	DO	Reset signal of camera	V_{OL}max = 0.20 V V_{OH}min = 1.46 V	
SCAM_PWDN	82	DO	Power down signal of camera	V_{OL}max = 0.20 V V_{OH}min = 1.46 V	
CAM_I2C_SCL	83	OD	I2C clock signal of camera		
CAM_I2C_SDA	84	OD	I2C data signal of camera		

Keypad Interfaces

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
PWRKEY	114	DI	Turn on/off the module	V_{IL}max = 0.60 V V_{IH}min = 1.30 V	Pull-up to VBAT internally.Active low.
RESET_N	225	DI	Reset the module	V_{IL}max = 0.60 V V_{IH}min = 1.30 V	Off by default and can be enabled via software configuration.
VOL_UP	95	DI	Volume up	V_{IL}max = 0.48 V V_{IH}min = 1.39 V	If it is not used, keep it open.Cannot be pull up. 1.85V power domain
VOL_DOWN	96	DI	Volume down	V_{IL}max = 0.48 V V_{IH}min = 1.39 V	If it is not used, keep it open.1.85V power domain

RGB LED light interface					
RGB_B	249	AI	LED control negative		Connect to the negative pole of LED, the maximum current is 27.7 mA.
RGB_R	252	AI	LED control negative		Connect to the negative pole of LED, the maximum current is 27.7 mA.
RGB_G	253	AI	LED control negative		Connect to the negative pole of LED, the maximum current is 27.7 mA.
SENSOR_I2C Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
SENSOR_I2C_SCL	91	OD	I2C clock signal for external sensor		1.85V power domain,Can be used as ordinary GPIO.
SENSOR_I2C_SDA	92	OD	I2C data signal for external sensor		
Universal I2C interface					
I2C4_SDA	167	OD	General peripheral I2C data signal		1.85V power domain.
I2C4_SCL	168	OD	General peripheral I2C clock signal		1.85V power domain.
ADC interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ADC	128	AI	General ADC interface		Maximum input voltage 1.2 V 。
Charge Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
BAT_SNS	133	AI	Battery voltage detection		Maximum input voltage is 4.2V.
CS_M	183	AI	Fuel gauge detection negative		Connect the fuel gauge to ground when not in use.

CS_P	184	AI	Fuel gauge detection positive		Connect the fuel gauge to ground when not in use.
BAT_THERM	134	AI	Battery temperature detection		10 kΩ NTC is supported by default, and a 10 kΩ NTC resistor must be connected to ground. If it is not used, an external 10 kΩ resistor must be connected to the ground.
BAT_ID	185	AI	Battery type detection		Input range: 0~1.2 V, floating if not used 。
Antenna interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ANT_MAIN	87	AI/ AO	ANT_MAIN		50Ω impedance
ANT_DRX	131	AI	ANT_DRX		
ANT_GNSS [1)]	121	AI	GNSS Antenna interface		
ANT_WIFI/BT	77	AI/ AO	Wi-Fi/BT Antenna interface		
GPIO interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
GPIO_87	33	IO	GPIO	V_{IL}max = 0.48 V V_{IH}min = 1.39 V V_{OL}max = 0.20 V V_{OH}min = 1.46 V	
GPIO_86	90	IO	GPIO		
GPIO_85	97	IO	GPIO		
GPIO_88	98	IO	GPIO		
GPIO_139	99	IO	GPIO		
GPIO_136	100	IO	GPIO		
GPIO_135	101	IO	GPIO		

GPIO_134	102	IO	GPIO		
GPIO_11	103	IO	GPIO		
GPIO_10	104	IO	GPIO		
GPIO_138	105	IO	GPIO		
GPIO_121	106	IO	GPIO		Can be reused as EXTINT11
GPIO_52	107	IO	GPIO		
GPIO_53	108	IO	GPIO		
GPIO_54	109	IO	GPIO		
GPIO_55	110	IO	GPIO		
GPIO_122	112	IO	GPIO		Can be reused as EXTINT12
GPIO_33	113	IO	GPIO		
GPIO_130	115	IO	GPIO		Can be reused as EXTINT13
GPIO_93	116	IO	GPIO		Can be reused as EXTINT8
GPIO_90	117	IO	GPIO		Can be reused as EXTINT5
GPIO_92	118	IO	GPIO		Can be reused as EXTINT7
GPIO_91	119	IO	GPIO		Can be reused as EXTINT6
GPIO_32	123	IO	GPIO		
GPIO_129	124	IO	GPIO		
GRFC interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
GRFC_7	260	DO	RF control output		It cannot be multiplexed into a Generic GPIO.
GRFC_5	262	DO	RF control output		
Other pins					

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
USB_BOOT	46	DI	Force the module to enter emergency download mode	V_{IL}max = 0.48 V V_{IH}min = 1.39 V	Pull down USB_BOOT to GND will force the module enter emergency download mode.
VIB_DRV_P	28	PO	Motor drive	V_O = 1.80~3.30 V $I_O$max = 100 mA	Connected to the positive terminal of the motor.
Reserved Interfaces					
Pin Name	**Pin No.**				**Comment**
RESERVED	32、126、127、153、154，155、157、158、159、160、161、163、164、165、166、169、170、173、174、175、177、178、179、180、181、182、186、192、193、194、195、196、197、198、199、200、201、205、232、239、242、246、254、257、263、264、265、267、270				Keep these pins open.

NOTES

[1)] SC200L-WF does not support GNSS.

3.4. Power Supply

3.4.1. Decrease Voltage Drop

SC200L provides two VBAT_RF pins and two VBAT_BB pins for connecting with an external power supply. The VBAT_RF pins are used for the RF part of the module and the VBAT_BB pins are used for the baseband part of the module.

3.4.2. Decrease Voltage Drop

The power supply range of the module is 3.50V~4.20V, and the recommended value is 3.80V. The power supply performance, such as load capacity, voltage ripple, etc. directly influences the module's performance and stability. Under ultimate conditions, the transient peak current of the module may surge up to 3A. If the supply voltage is not enough, there will be voltage drops, and if the voltage drops below 3.1V, the module will be turned off automatically. Therefore, please make sure the input voltage will never drop below 3.1V.

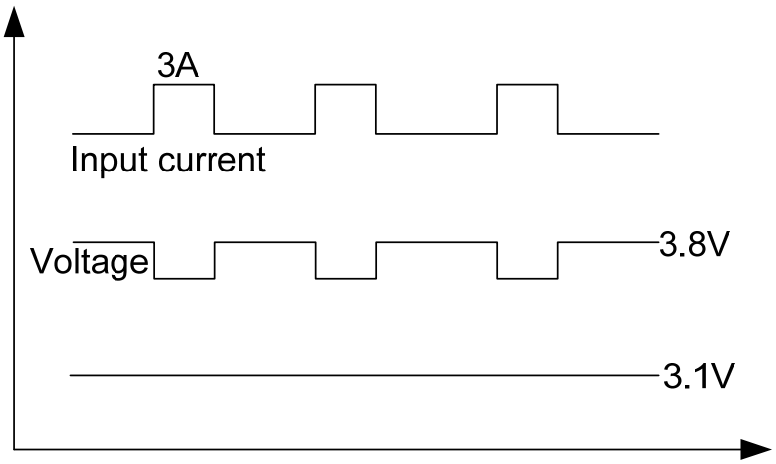


Figure 2: Voltage Drop Sample

To decrease voltage drop, a bypass capacitor of about 100μF with low ESR (ESR=0.7Ω) should be used, and a multi-layer ceramic chip capacitor (MLCC) should also be reserved due to its ultra-low ESR. It is recommended to use three ceramic capacitors (100nF, 33pF, 10pF) for composing the MLCC array and place these capacitors close to VBAT_BB/RF pins. The main power supply from an external application has to be a single voltage source and can be expanded to two sub paths with star structure. The width of VBAT_BB trace should be no less than 3 mm. In principle, the longer the VBAT trace is, the wider it will be.

In addition, in order to get a stable power source, it is suggested to use a TVS and place it as close to the VBAT_BB/RF pins as possible to increase voltage surge withstand capability. The following figure shows the star structure of the power supply.

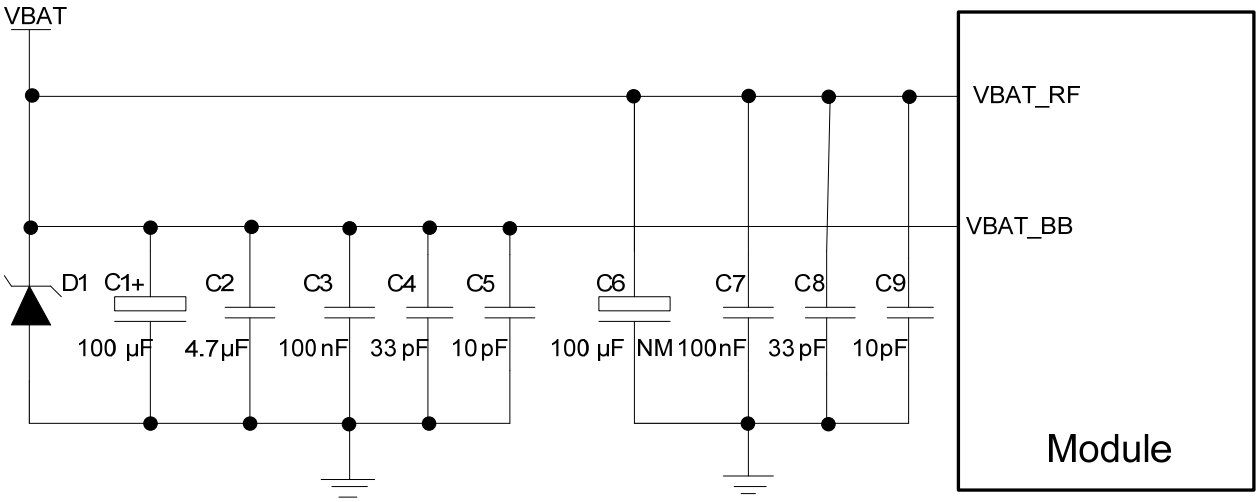


Figure 3: Star Structure of the Power Supply

3.4.3. Reference Design for Power Supply

The power design for the module is very important, as the performance of the module largely depends on the power source. The power supply of SC200L should be able to provide sufficient current up to 3A at least. If the voltage drop between the input and output is not too high, it is suggested to use an LDO to supply power for the module. If there is a big voltage difference between the input source and the desired output (VBAT), a buck converter is recommended.

The following figure shows a reference design for +5V input power source.

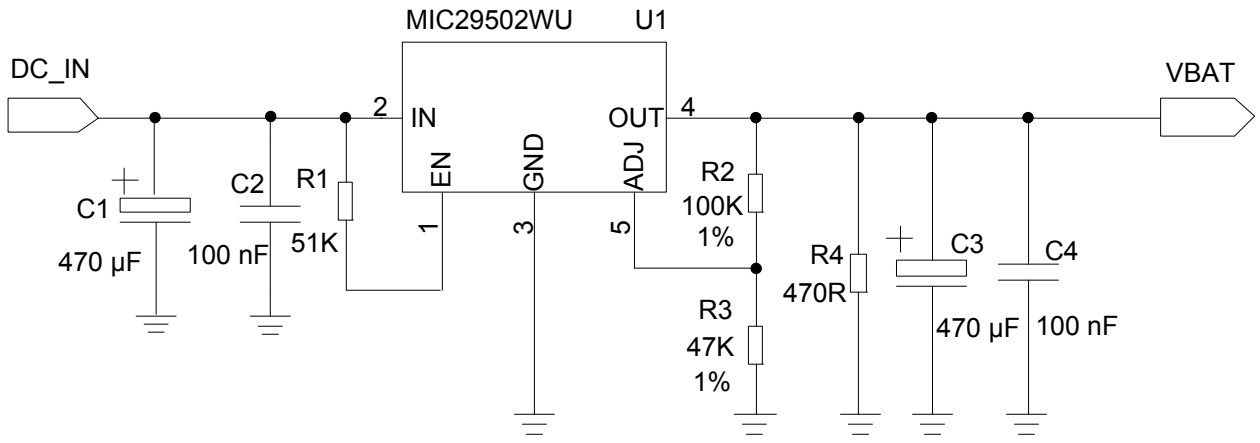


Figure 4: Reference Circuit of Power Supply

NOTES

1. It is suggested that customers should switch off the power supply for the module in an abnormal state, and then switch on the power to restart the module.
2. The module supports the battery charging function by default. If the above power supply design is adopted, please make sure the charging function is disabled by software or connect VBAT to Schottky diode in series to avoid the reverse current to the power supply chip.

3.5. Turn on and off Scenarios

3.5.1. Turn on Module Using the PWRKEY

The module can be turned on by driving the PWRKEY pin to a low level for at least 2.5s. PWRKEY pin is pulled to VBAT internally. It is recommended to use an open drain/collector driver to control the PWRKEY. A simple reference circuit is illustrated in the following figure.

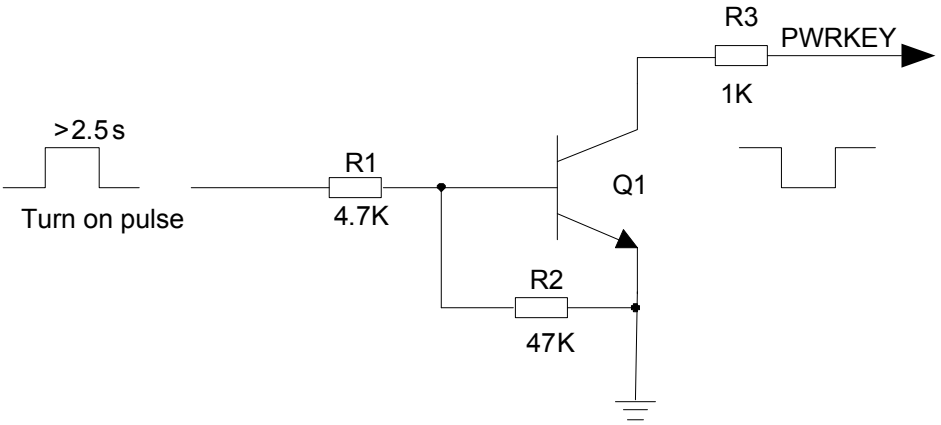


Figure 5: Turn on the Module Using Driving Circuit

The other way to control the PWRKEY is by using a button directly. A TVS component is indispensable to be placed nearby the button for ESD protection. A reference circuit is shown in the following figure.

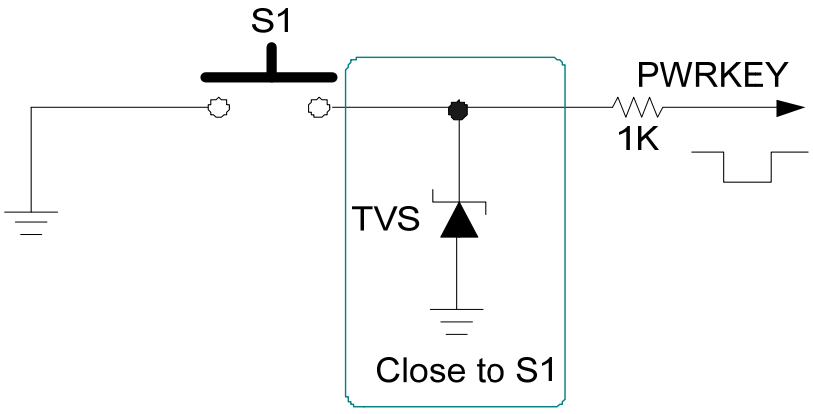


Figure 6: Turn on the Module Using Keystroke

The turning on the scenario is illustrated in the following figure.

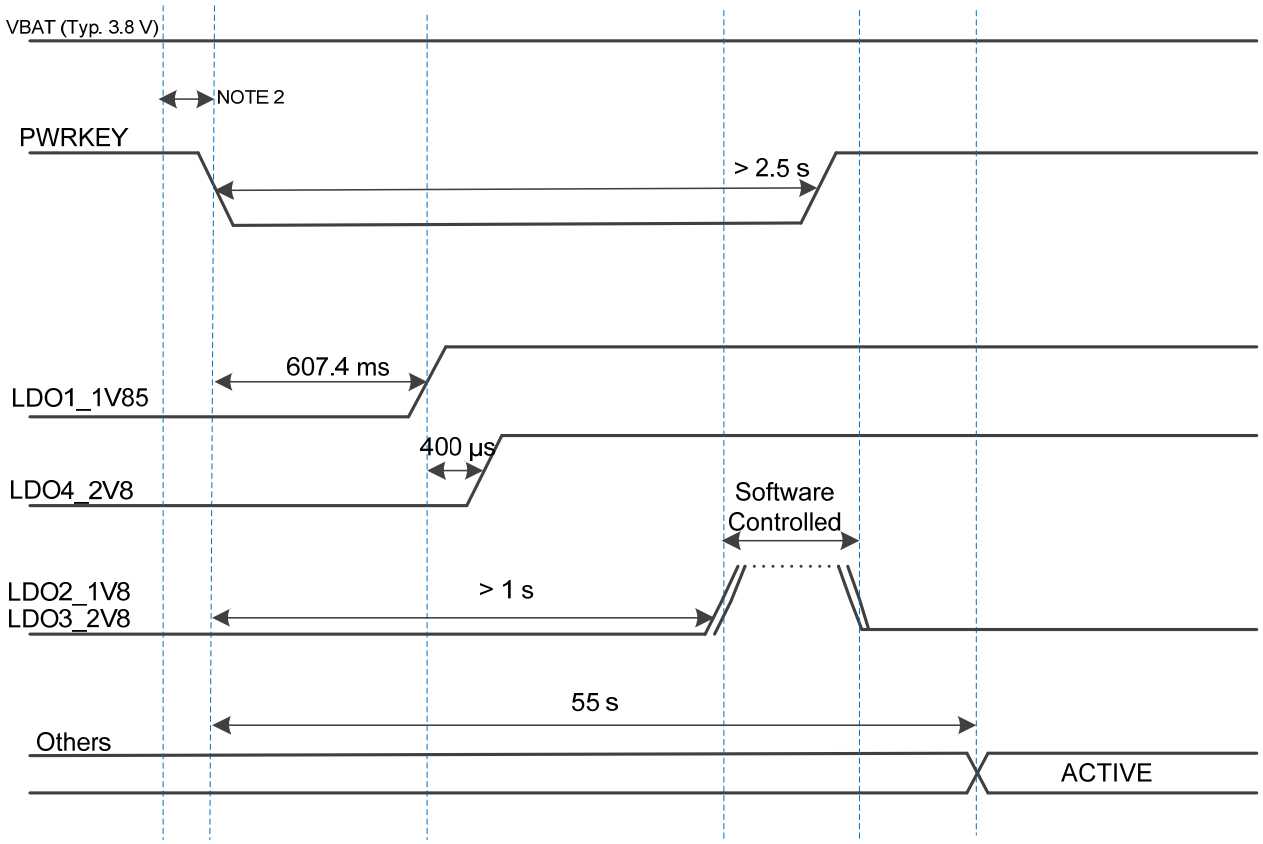


Figure 7: Timing of Turning on Module

NOTES

1. When the module is powered on for the first time, its timing of turning on may be different from that shown above.
2. Make sure that VBAT is stable before pulling down the PWRKEY pin. The recommended time between them is no less than 30ms. PWRKEY pin cannot be pulled down all the time.

3.5.2. Turn off Module

Set the PWRKEY pin low for at least 1s, and then choose to turn off the module when the prompt window comes up.
It can also be forced to restart by pulling down the PWRKEY key for a long time (more than 7 seconds). The restart sequence diagram is as follows:

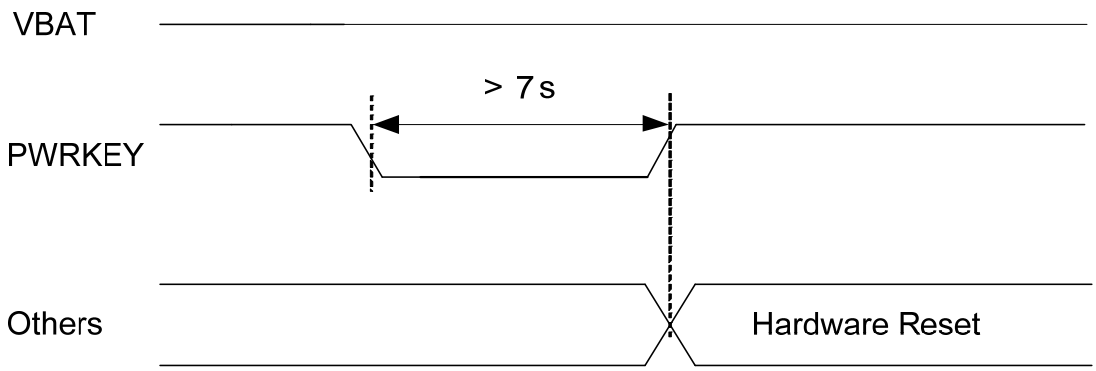


Figure 8: Restart timing diagram

3.6. Power Output

SC200L supports the output of regulated voltages for peripheral circuits. During application, it is recommended to use parallel capacitors (33pF and 10pF) in the circuit to suppress high-frequency noise.

Table 6: Power Description

Pin Name	Default Voltage (V)	Driving Current (mA)	IDLE
LDO1_1V85	1.85	100	KEEP
LDO2_1V8	1.80	500	/
LDO3_2V8	2.80	150	/
LDO4_2V8	2.80	200	KEEP
SD_VDD	3.00	400	/
USIM1_VDD	1.80/2.95	50	/
USIM2_VDD	1.80/2.95	50	/

3.7. Battery Charge and Management

SC200L module can recharge batteries. The battery charger in the SC200L module supports trickle charging, constant current charging and constant voltage charging modes.

- **Trickle charging:** There are two steps in this mode. When the battery voltage is between 1.1V and 2.05V, a 70mA trickle charging current is applied to the battery. When the battery voltage is charged up and is between 2.05V and 3.05V, the charging current can be set to 450mA maximally.
- **Constant current mode (CC mode):** When the battery is increased to between 3.05V and 4.18V, the system will switch to CC mode. The charging current is 0.9A when an adapter is used for battery charging, and the maximum charging current is 450mA for USB charging.
- **Constant voltage mode (CV mode):** When the battery voltage reaches the final value 4.18V, the system will switch to CV mode and the charging current will decrease gradually. When the battery level reaches 100%, the charging is completed.

Table 7: Description of charging interface

Pin Name	Pin No.	I/O	Description	Comment
BAT_SNS	133	AI	Battery voltage detection	The maximum input voltage is 4.50 V.
CS_M	183	AI	Fuel gauge detection negative	Connect the fuel gauge to ground when not in use.
CS_P	184	AI	Fuel gauge detection positive	Connect the fuel gauge to ground when not in use.
BAT_THERM	134	AI	Battery temperature detection	10 kΩ NTC is supported by default, and a 10 kΩ NTC resistor must be connected to ground. If it is not used, an external 10 kΩ resistor must be connected to the ground.
BAT_ID	185	AI	Battery type detection	Input range: 0~1.2 V, if not used, leave it open.

SC200L module supports battery temperature detection in the condition that the battery integrates a thermistor (47KΩ 1% NTC thermistor with a B-constant of 3380KΩ by default; the thermistor is connected to VBAT_THERM pin. If the VBAT_THERM pin is not connected, there will be malfunctions such as battery charging failure, battery level display error, etc.

A reference design for the battery charging circuit is shown below.

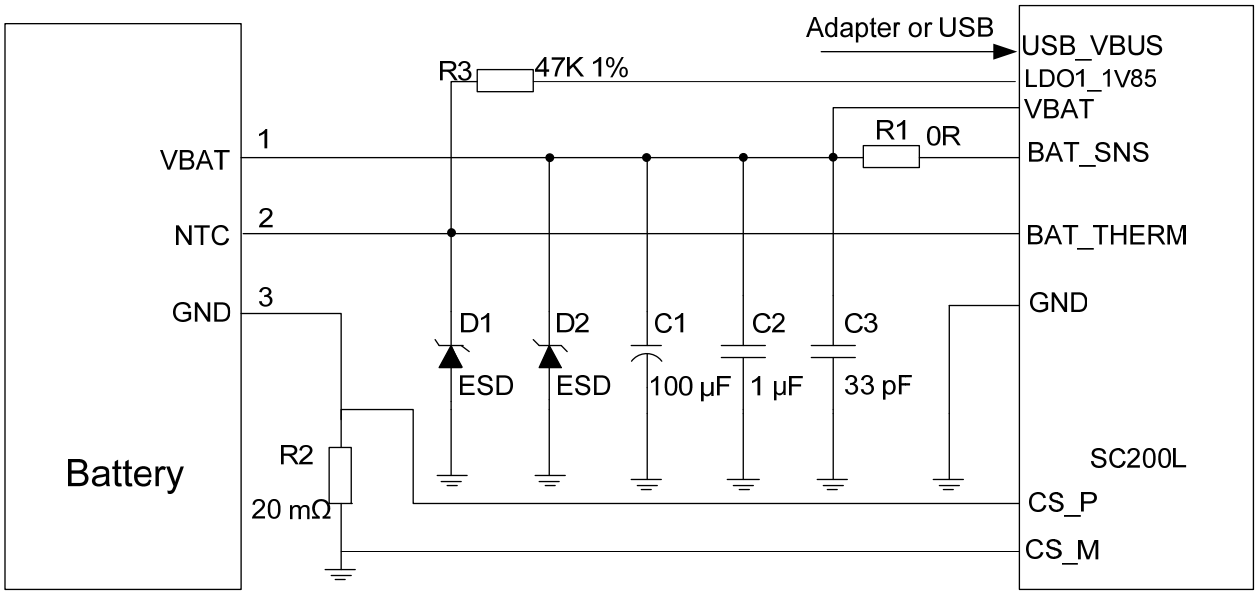


Figure 9: Reference Design for Battery Charging Circuit

Mobile devices such as mobile phones and handheld POS systems are powered by batteries. When different batteries are utilized, the charging and discharging curve has to be modified correspondingly so as to achieve the best effect.

If the thermistor is not available in the battery, or adapter is utilized for powering the module, then there is only a need for VBAT and GND connection. In this case, the system may mistakenly judge that the battery temperature is abnormal, which will cause battery charging failure. In order to avoid this, VBAT_THERM should be connected to GND via a 10KΩ resistor. If VBAT_THERM is unconnected, the system will be unable to detect the battery, making the battery cannot be charged.

VBAT_SNS pin must be connected. Otherwise, the module will have abnormalities in voltage detection, as well as an associated power on/off and battery charging and discharging issues.

The SC200L series module supports current-type current meter by default, and conducts current sampling through a 20 mΩ sampling resistor R2.

3.8. USB Interface

SC200L contains one integrated Universal Serial Bus (USB) interface which complies with the USB 2.0 specification and supports high speed (480Mbps) and full-speed (12Mbps) modes. The USB interface is used for AT command communication, data transmission, software debugging and firmware upgrade.

The following table shows the pin definition of the USB interface.

Table 8: Pin Definition of USB Interface

Pin Name	Pin No.	I/O	Description	Comment
USB_VBUS	141、142	PI	USB power supply	Vmax = 9.20 V Vmin = 4.50 V Vnorm = 5.00 V
USB_DM	13	AI/AO	USB 2.0 differential data bus (-)	USB 2.0 standard compliant. 90Ω differential impedance.
USB_DP	14	AI/AO	USB differential data bus (+)	
USB_ID	16	DI	USB ID detection of the input	

For USB 2.0 interface design, it is recommended that USB_ID should be directly connected to the USB_ID pin of an external USB port for USB ID detection. When a device inserts an external USB port, if it pulls down the USB_ID pin of the module, the module will enter the Host mode.

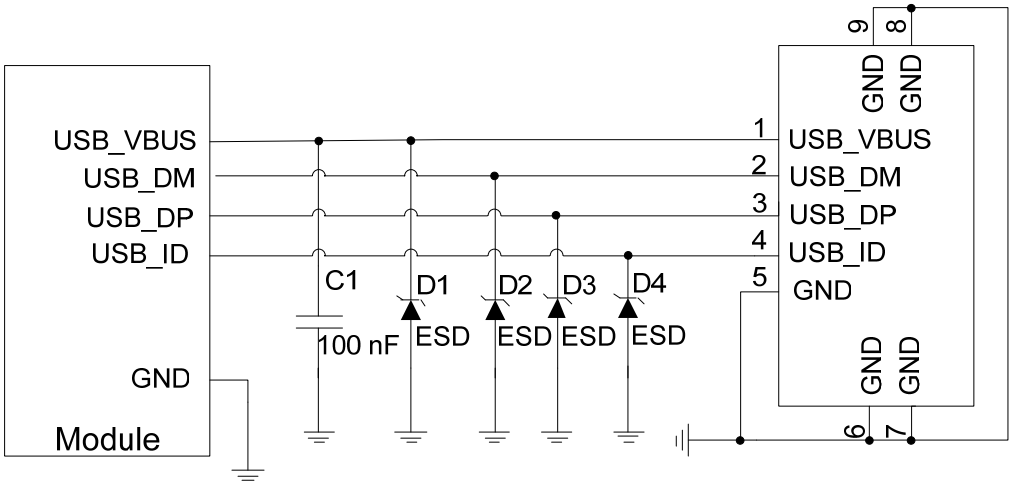


Figure 10: USB Interface Reference Design (OTG is not Supported)

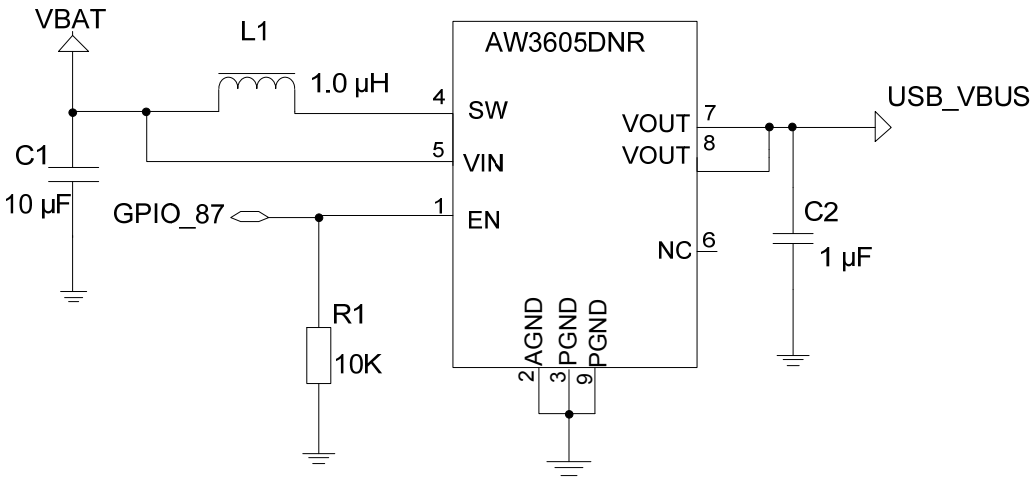


Figure 11: USB OTG Interface Reference Design

In order to ensure USB performance, please comply with the following principles while designing a USB interface.

- It is important to route the USB signal traces as differential pairs with total grounding. The impedance of USB differential trace is 90Ω.
- Keep the ESD protection devices as close as possible to the USB connector. Pay attention to the influence of junction capacitance of ESD protection devices on USB data lines. Typically, the capacitance value should be less than 2pF.
- Do not route signal traces under crystals, oscillators, magnetic devices, and RF signal traces. It is important to route the USB differential traces in inner-layer with ground shielding on not only the upper and lower layers but also the right and left sides.
- Make sure the trace length difference of USB 2.0 is not exceeding 0.7 mm.

Table 9: USB Trace Length Inside the Module

PIN	Signal	Length (mm)	Length Difference (DP-DM)
13	USB_DM	17.67	0.17
14	USB_DP	17.50	

3.9. UART Interfaces

SC200L provides two UART interfaces:

- UART0**:** 4-wire UART interface, hardware flow control supported.
- UART1（DEBUG）**:** 2-wire UART interface; used for debugging by default.

The UART interface pin definition is as follows:

Table 10: Pin Definition of UART Interfaces

Pin Name	Pin No	I/O	Description	Comment
UART0_TXD	34	DO	UART0 transmit data	1.8V power domain. If unused, keep it open.
UART0_RXD	35	DI	UART0 receive data	
UART0_CTS	36	DI	UART0 clear to send	
UART0_RTS	37	DO	UART0 request to send	
DBG_RXD	93	DI	UART1 receive data. Debug port by default.	
DBG_TXD	94	DO	UART2 transmit data. Debug port by default.	

UART0 is a 4-wire UART interface with 1.85V power domain. A level translator should be used if customers' application is equipped with a 3.3V UART interface.

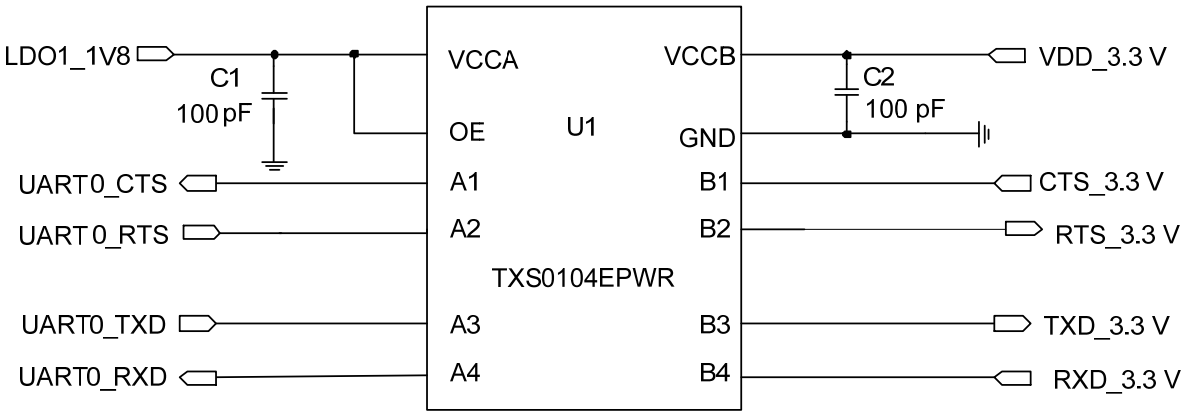


Figure 12: Reference Circuit with Level Translator Chip (for UART5)

The following figure is an example of a connection between SC200L and PC. A voltage level translator and an RS-232 level translator chip are also recommended to be added between the module and PC. The

following figure shows the reference design.

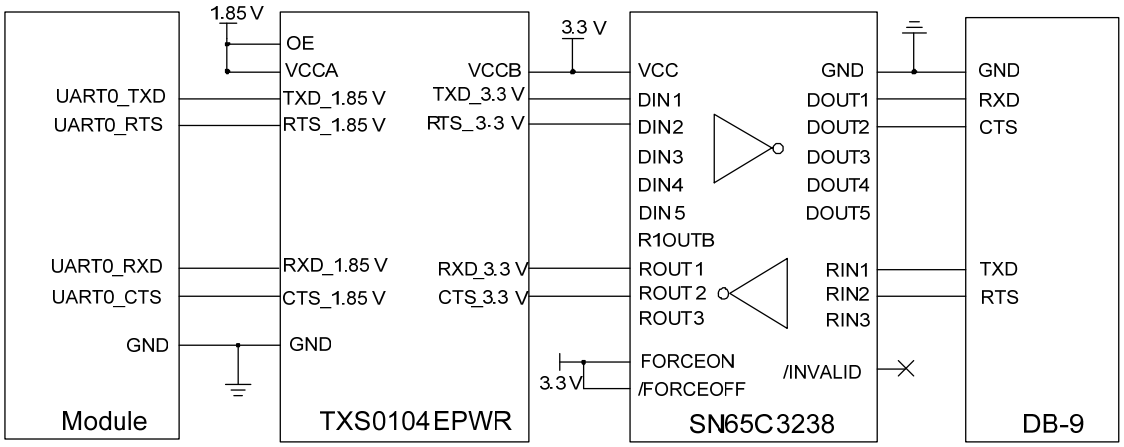


Figure 13: RS-232 Level Match Circuit (for UART0)

NOTE

Please note that the CTS and RTS pins of the serial port hardware flow control are directly connected, and pay attention to the input and output directions.

3.10. (U)SIM Interface

SC200L provides 2 (U)SIM interfaces that meet ETSI and IMT-2000 requirements. Dual SIM Card Dual Standby is supported by default. Both 1.8V and 2.95V (U)SIM cards are supported, and the (U)SIM card interfaces are powered by the internal power supply of the SC200L module.

Table 11: Pin Definition of (U)SIM Interfaces

Pin Name	Pin No	I/O	Description	Comment
USIM2_DET	17	DI	(U)SIM2 card plug detection	Active Low. If it is not used, keep it open.Enabled by default via software.It can be multiplexed into a generic GPIO.
USIM2_RST	18	DO	(U)SIM2 card reset signal	It cannot be multiplexed into a generic GPIO.
USIM2_CLK	19	DO	(U)SIM2 card clock signal	It cannot be multiplexed into a generic GPIO.
USIM2_DATA	20	IO	(U)SIM2 card data signal	It cannot be multiplexed into a generic GPIO.

USIM2_VDD	21	PO	(U)SIM2 card power supply	Either 1.8V or 2.95V (U)SIM card is supported.
USIM1_DET	22	DI	(U)SIM1 card plug detection	Active Low. If it is not used, keep it open.Enabled by default via software.It can be multiplexed into a generic GPIO.
USIM1_RST	23	DO	(U)SIM1 card reset signal	It cannot be multiplexed into a generic GPIO.
USIM1_CLK	24	DO	(U)SIM1 card clock signal	It cannot be multiplexed into a generic GPIO.
USIM1_DATA	25	IO	(U)SIM1 card data signal	It cannot be multiplexed into a generic GPIO.
USIM1_VDD	26	PO	(U)SIM1 card power supply	Either 1.8V or 2.95V (U)SIM card is supported.

SC200L supports (U)SIM card hot-plug via the USIM_DET pin. A reference circuit for (U)SIM interface with an 8-pin (U)SIM card connector is shown below.

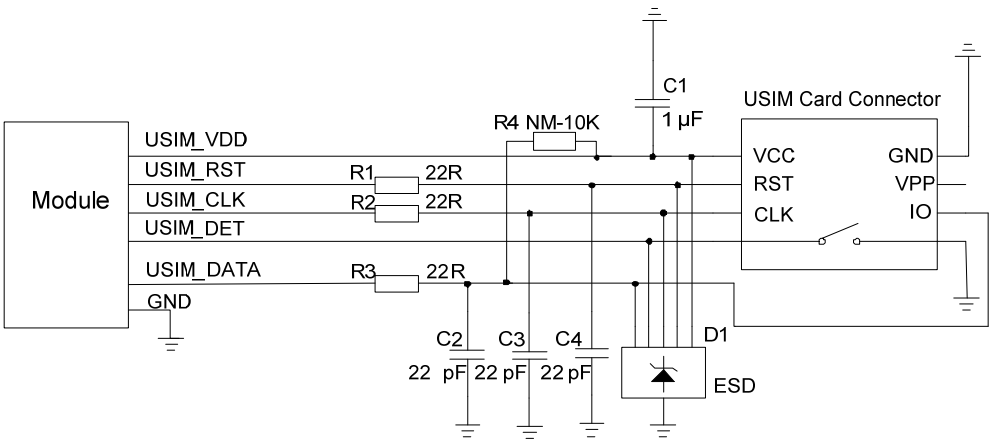


Figure 14: Reference Circuit for (U)SIM Interface with an 8-pin (U)SIM Card Connector

If there is no need to use USIM_DET, please keep this pin open. The following is a reference circuit for (U)SIM interface with a 6-pin (U)SIM card connector.

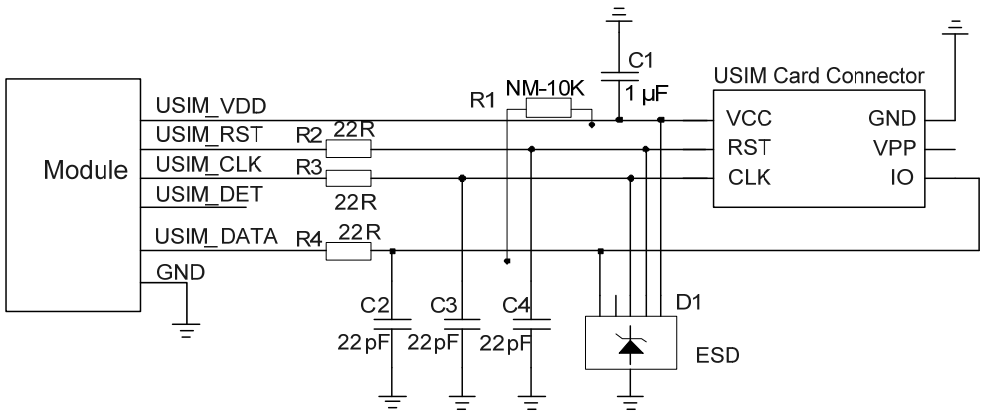


Figure 15: Reference Circuit for (U)SIM Interface with a 6-pin (U)SIM Card Connector

In order to ensure good performance and avoid damage of (U)SIM cards, please follow the criteria listed below during (U)SIM circuit design:

- Keep placement of (U)SIM card connector as close to the module as possible. Keep the trace length of (U)SIM card signals as less than 200 mm as possible.
- Keep (U)SIM card signals away from RF and VBAT traces.
- A filter capacitor shall be reserved for USIM_VDD, and its maximum capacitance should not exceed 1µF. The capacitor should be placed near to (U)SIM card.
- To avoid cross-talk between USIM_DATA and USIM_CLK, keep them away from each other and shield them with ground. USIM_RST also needs ground protection.
- In order to offer good ESD protection, it is recommended to add a TVS diode array with parasitic capacitance not exceeding 50pF. The 22Ω resistors should be added in series between the module and (U)SIM card so as to suppress EMI spurious transmission and enhance ESD protection. Please note that the (U)SIM peripheral circuit should be close to the (U)SIM card connector.
- The 22pF capacitors should be added in parallel on USIM_DATA, USIM_VDD, USIM_CLK and USIM_RST signal lines so as to filter RF interference, and they should be placed as close to the (U)SIM card connector as possible.

3.11. SD Card Interface

SC200L SD Card Interface supports the SD 3.0 protocol. The pin definition of the SD card interface is shown below.

Table 12: Pin Definition of SD Card Interface

Pin Name	Pin No	I/O	Description	Comment	Pin Name

SD_CLK	39	DO	High-speed digital clock signal of SD card	50Ω characteristic impedance
SD_CMD	40	IO	Command signal of SD card	
SD_DATA0	41	IO	High-speed bidirectional digital signal lines of SD card	
SD_DATA1	42	IO		
SD_DATA2	43	IO		
SD_DATA3	44	IO		
SD_DET	45	DI	SD card insertion detection	Active low
SD_VDD	38	PO	3V output power supply	Power supply for SD card

A reference circuit for the SD card interface is shown below.

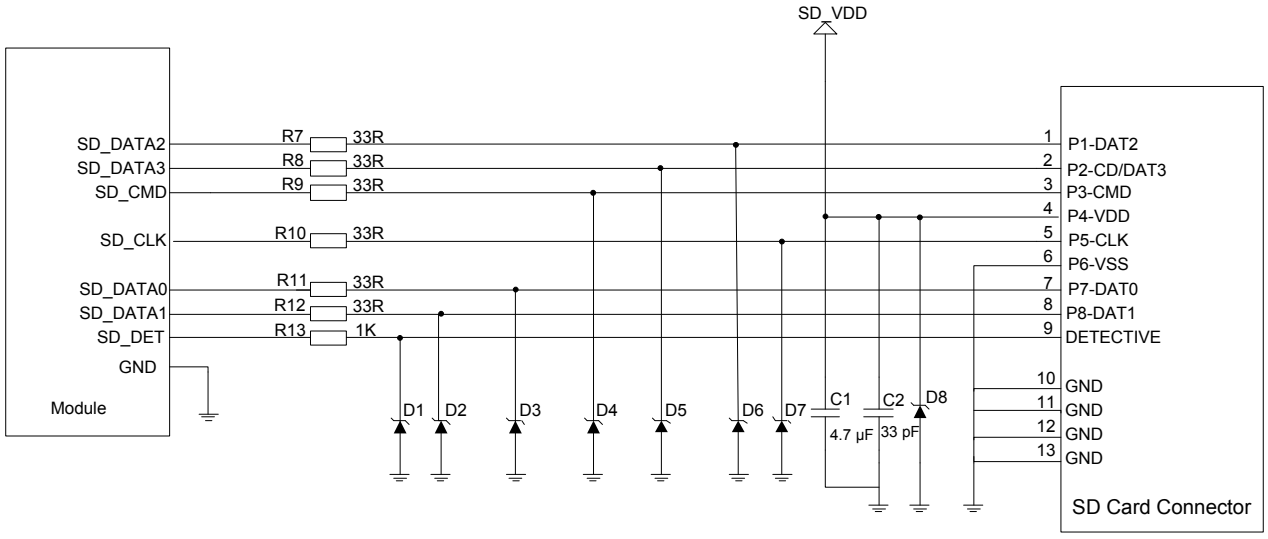


Figure 16: Reference Circuit for SD Card Interface

SD_VDD is a peripheral driver power supply for an SD card. The maximum drive current is 500mA. Because of the high drive current, it is recommended that the trace width is 0.5 mm or above. In order to ensure the stability of drive power, a 4.7μF and a 33pF capacitor should be added in parallel near the SD card connector.

CMD, CLK, DATA0, DATA1, DATA2, and DATA3 are all high-speed signal lines. In PCB design, please control the characteristic impedance of them to 50Ω, and do not cross them with other traces. It is

recommended to route the trace on the inner layer of PCB and keep the same trace length for CLK, CMD, DATA0, DATA1, DATA2 and DATA3. CLK needs separate ground shielding.
Layout guidelines:

- Control impedance to 50Ω ±10% and ground shielding is required.
- The total trace length difference between CLK and other signal line traces like CMD and DATA should not exceed 1 mm.

Table 13: SD Card Trace Length Inside the Module

Pin No.	Signal	Length (mm)
39	SD_CLK	43.50
40	SD_CMD	42.82
41	SD_DATA0	45.92
42	SD_DATA1	46.24
43	SD_DATA2	43.97
44	SD_DATA3	45.62

3.12. GPIO Interfaces

SC200L has abundant GPIO interfaces with a power domain of 1.85V. The pin definition is listed below.

Table 14: Pin Definition of GPIO Interfaces

Pin Name	Pin No	GPIO	Default state	Comment
GPIO_87	33	GPIO_87	IN/PD [1)]	
GPIO_86	90	GPIO_86	IN/PU	
GPIO_85	97	GPIO_85	OUT/Hiz	
GPIO_88	98	GPIO_88	IN/PU	
GPIO_139	99	GPIO_139	IN/PU	
GPIO_136	100	GPIO_136	IN/PU	

GPIO_135	101	GPIO_135	IN/PU	
GPIO_134	102	GPIO_134	IN/PD	
GPIO_11	103	GPIO_11	IN/PD	
GPIO_10	104	GPIO_10	IN/PD	
GPIO_138	105	GPIO_138	IN/PU	
GPIO_121	106	GPIO_121	OUT/L	Can be reused as EXTINT11
GPIO_52	107	GPIO_52	IN/PU	
GPIO_53	108	GPIO_53	IN/PD	
GPIO_54	109	GPIO_54	IN/PD	
GPIO_55	110	GPIO_55	IN/PD	
GPIO_122	112	GPIO_122	IN/PD	Can be reused as EXTINT12
GPIO_33	113	GPIO_33	IN/PD	
GPIO_130	115	GPIO_130	IN/PD	Can be reused as EXTINT13
GPIO_93	116	GPIO_93	IN/PD	Can be reused as EXTINT8
GPIO_90	117	GPIO_90	IN/PU	Can be reused as EXTINT5
GPIO_92	118	GPIO_92	IN/PD	Can be reused as EXTINT7
GPIO_91	119	GPIO_91	IN/PD	Can be reused as EXTINT6
GPIO_32	123	GPIO_32	IN/PD	
GPIO_129	124	GPIO_129	IN/PD	

NOTE

1. 1) PD: pull-down; PU: pull-up; IN: input; OUT: output; L: low level; H: high level; Hiz: high impedance.
2. For detailed configuration of GPIO, please refer to document [3].
3. External inputs with hardware mechanical jitter, such as buttons and OTG ID pins, must be selected as GPIO that can be multiplexed into EXTINT functions.

4. For the EN pin of flash, switch charging, DC/DC and other chips, please select the PD's GPIO control by default.
5. When ordinary GPIO is used as an input interrupt, edge wakeup is not supported when the system sleeps, only level wakeup is supported.

3.13. I2C Interfaces

SC200L module provides four I2C interfaces. As an open-drain signal, the I2C interfaces need a pull-up resistor on its external circuit, and the recommended power domain is 1.85V.

Table 15: Pin Definition of I2C Interfaces

Pin Name	Pin No	I/O Description	Comment	Pin Name
TP_I2C_SCL	47	OD	I2C clock signal of touch panel	Used for touch panel
TP_I2C_SDA	48	OD	I2C data signal of touch panel	
CAM_I2C_SCL	83	OD	I2C clock signal of camera	Used for camera
CAM_I2C_SDA	84	OD	I2C data signal of camera	
I2C4_SCL	168	OD	General peripheral I2C clock signal	For external equipment
I2C4_SDA	167	OD	General peripheral I2C data signal	
SENSOR_I2C_SCL	91	OD	I2C clock signal for external sensor	Used for external sensor
SENSOR_I2C_SDA	92	OD	I2C data signal for external sensor	

3.14. SPI Interfaces

SC200L provides three SPI interfaces, which are multiplexed from UART and GPIO interfaces. These interfaces can only support the master mode. SPI interfaces can be used for fingerprint recognition.

Table 16: Pin Definition of SPI Interfaces

Pin Name	Pin No	I/O	Description	Comment
GPIO_52	107	DO	SPI2 chip select signal	Multiplexed as SPI2_CSN
GPIO_53	108	DO	SPI2 data output	Multiplexed as SPI2_DO
GPIO_54	109	DI	SPI2 data input	Multiplexed as SPI2_DI
GPIO_55	110	DO	SPI2 clock signal	Multiplexed as SPI2_CLK
GPIO_93	116	DO	SPI0 clock signal	Multiplexed as SPI0_CLK
GPIO_90	117	DO	SPI0 chip select signal	Multiplexed as SPI0_CSN
GPIO_92	118	DI	SPI0 data input	Multiplexed as SPI0_DI
GPIO_91	119	DO	SPI0 data output	Multiplexed as SPI0_DO
GPIO_139	99	DO	SPI1 chip select signal	Multiplexed as SPI1_CSN
GPIO_136	100	DO	SPI1 data output	Multiplexed as SPI1_DO
GPIO_135	101	DI	SPI1 data input	Multiplexed as SPI1_DI
GPIO_134	102	DO	SPI1 clock signal	Multiplexed as SPI1_CLK

3.15. ADC Interface

SC200L supports a analog-to-digital converter (ADC) interface, and the pin definition is shown below.

Table 17: Pin Definition of ADC Interfaces

Pin Name	Pin No	I/O Description	Comment	Pin Name
ADC	128	AI	Generic ADC	The maximum input voltage is 1.2V.

3.16. LCM Interface

SC200L provides an LCM interface, which is MIPI_DSI standard compliant. The interface supports high-speed differential data transmission and supports HD+ display (1440x720 @60fps). The pin definition of the LCM interface is shown below.

Table 18: Pin Definition of LCM Interface

Pin Name	Pin No	I/O	Description	Comment
LDO2_1V8	125	PO	1.80 V output;Provide enable signal for external LCD I/O port power supply	Vnorm = 1.80 V $I_O$max = 500 mA
LDO4_2V8	156	PO	2.80V output power supply for LCD VCC	Vnorm = 2.80 V $I_O$max = 200 mA
PWM	29	DO	Adjust the backlight brightness,PWM control signal	1.85 V voltage domain Can be used as ordinary GPIO
LCD_RST	49	DO	LCD reset signal	1.85 V voltage domain Can be used as ordinary GPIO
LCD_TE	50	DI	LCD tearing effect signal	1.85 V voltage domain Can be used as ordinary GPIO
DSI_CLK_N	52	AO	LCD MIPI clock signal (-)	
DSI_CLK_P	53	AO	LCD MIPI clock signal (+)	
DSI_LN0_N	54	AO	LCD MIPI data signal 0 (-)	
DSI_LN0_P	55	AO	LCD MIPI data signal 0 (+)	
DSI_LN1_N	56	AO	LCD MIPI data signal 1 (-)	
DSI_LN1_P	57	AO	LCD MIPI data signal 1 (+)	
DSI_LN2_N	58	AO	LCD MIPI data signal 2 (-)	
DSI_LN2_P	59	AO	LCD MIPI data signal 2 (+)	
DSI_LN3_N	60	AO	LCD MIPI data signal 3 (-)	
DSI_LN3_P	61	AO	LCD MIPI data signal 3 (+)	

A reference circuit for the LCM interface is shown below.

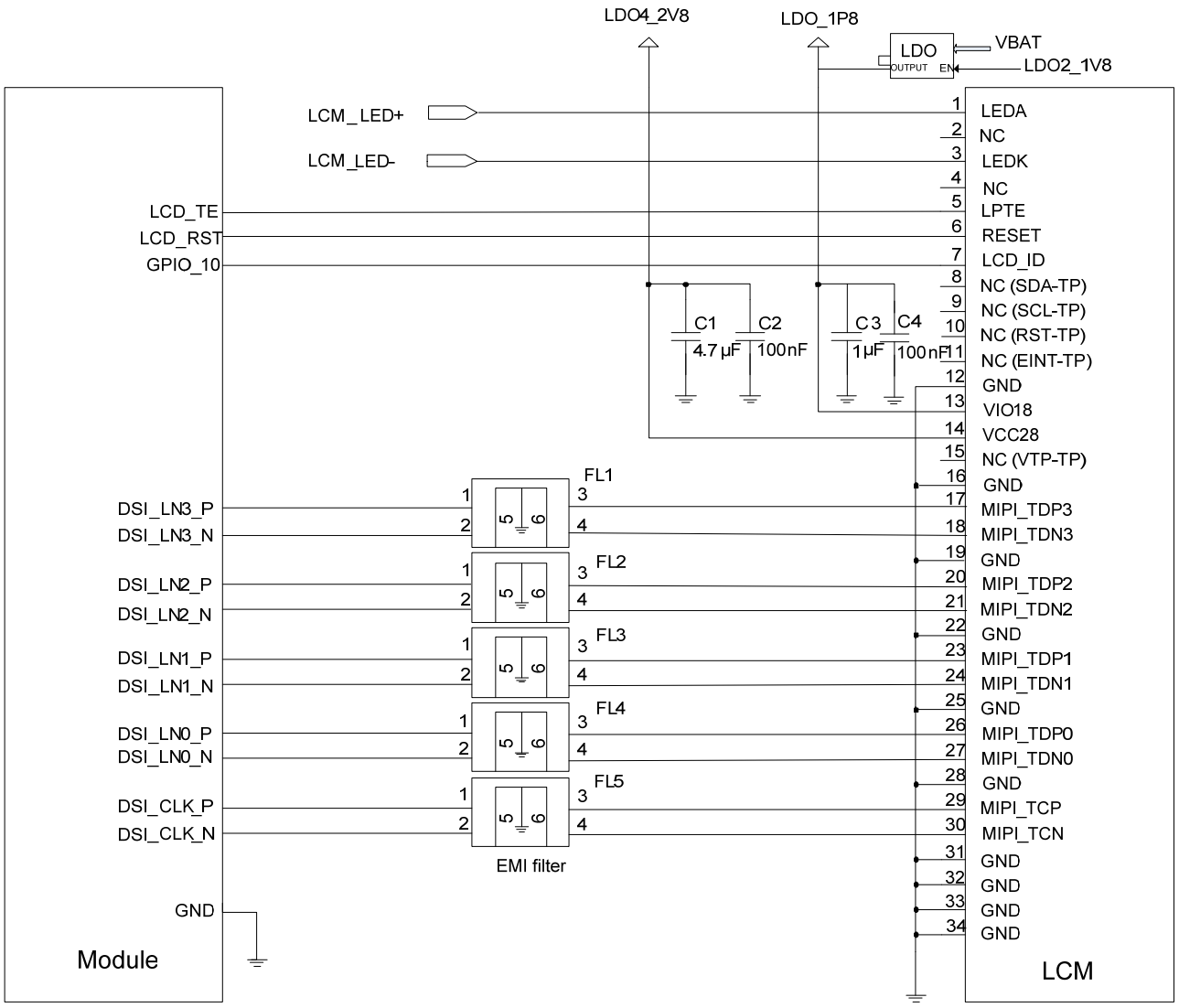


Figure 17: Reference Circuit Design for LCM Interface

MIPI is high-speed signal lines. It is recommended that common-mode filters should be added in series near the LCM connector, so as to improve protection against electromagnetic radiation interference.

It is recommended to read the LCM ID register through MIPI when compatible design with other displays is required. If several LCM models share the same IC, it is recommended that the LCM module factory burn the OTP register to distinguish different screens. Customers can also select the LCD_ID pin of LCM to connect the ADC pin of the SC200L module.

The external backlight driving circuit needs to be designed for LCM, and a reference circuit design is shown in the following figure. The backlight brightness adjustment can be realized by the PWM pin of the SC200L module by adjusting the duty ratio.

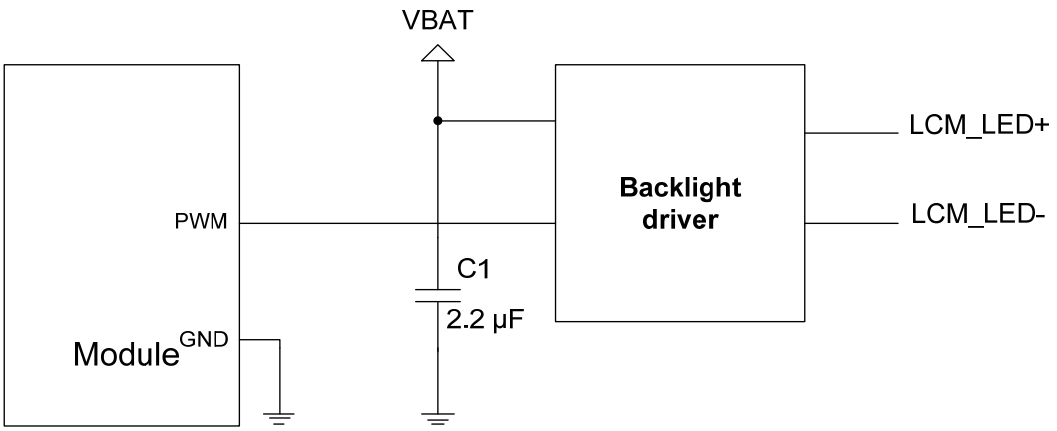


Figure 18: Reference Design for External Backlight Driving Circuit

3.17. Touch Panel Interface

SC200L provides one I2C interface for connection with Touch Panel (TP), and also provides the corresponding power supply and interrupt pins. The definitions of TP interface pins are illustrated below.

Table 19: Pin Definition of Touch Panel Interface

Pin Name	Pin No	I/O	Description	Comment
LDO4_2V8	156	PO	2.80V output power supply for TP VDD	Vnorm = 2.80 V $I_O$max = 200 mA
LDO2_1V8	125	PO	1.8V output power supply for TP I/O power	Vnorm = 1.80 V $I_O$max = 500 mA
TP_INT	30	DI	Interrupt signal of TP	1.85 V voltage domain Can be used as ordinary GPIO
TP_RST	31	DO	Reset signal of TP	1.85 V voltage domain Can be used as ordinary GPIO
TP_I2C_SCL	47	OD	I2C clock signal of TP	1.85 V voltage domain, can be used as ordinary GPIO without external pull-up Can be used for other I2C devices
TP_I2C_SDA	48	OD	I2C data signal of TP	

A reference circuit for the TP interface is shown below.

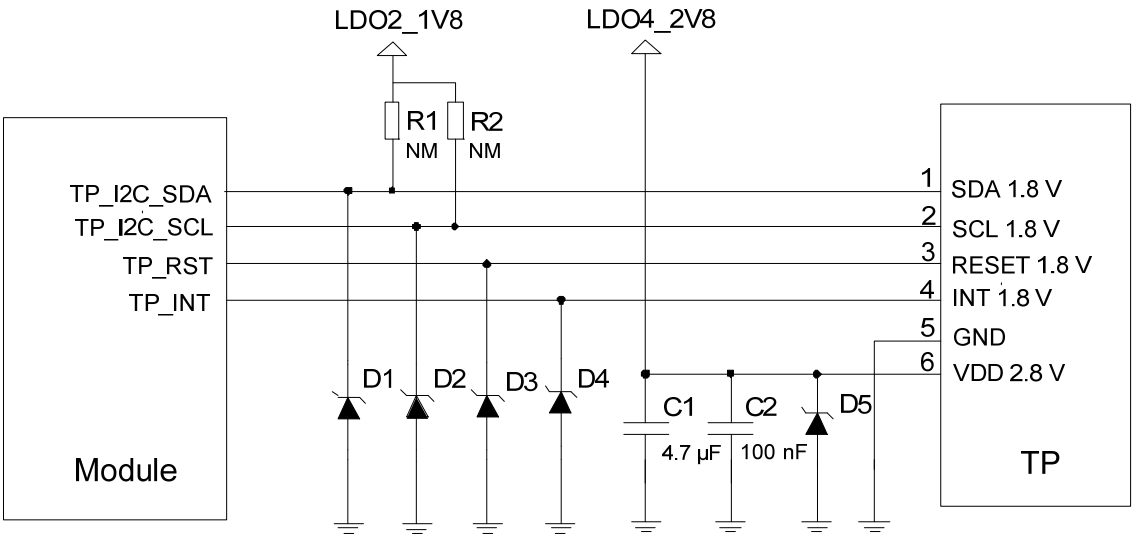


Figure 19: Reference Circuit Design for TP Interface

NOTE

The touch screen uses LDO4_2V8 power supply by default (normally open). LDO4_2V8 can output 200 mA current。

3.18. Camera Interface

Based on the standard MIPI CSI video input interface, the SC200L module supports two cameras (2-lane + 1-lane), Front-camera 1-lane MIPI, can support up to 2 MP photography; rear-camera 2-lane MIPI, can support up to 8 MP photography.The video and photo quality is determined by various factors such as the camera sensor, camera lens quality, etc.

Table 20: Pin Definition of Camera Interface

Pin Name	Pin No	I/O	Description	Comment
LDO2_1V8	125	PO	1.8V output power supply for DOVDD of camera	Vnorm = 1.80 V $I_O$max = 500 mA
LDO3_2V8	129	PO	2.80V output power supply for AVDD and AFVDD of camera	Vnorm = 2.80 V $I_O$max = 150 mA
CSI1_CLK_N	63	AI	CAMERA MIPI clock signal (-)	
CSI1_CLK_P	64	AI	CAMERA MIPI clock signal (+)	
CSI1_LN0_N	65	AI	CAMERA MIPI data0 signal (-)	

CSI1_LN0_P	66	AI	CAMERA MIPI data0 signal (+)	
CSI1_LN1_N	67	AI	CAMERA MIPI data1 signal (-)	
CSI1_LN1_P	68	AI	CAMERA MIPI data1 signal (+)	
CSI0_CLK_N	70	AI	CAMERA MIPI clock signal (-)	
CSI0_CLK_P	71	AI	CAMERA MIPI clock signal (+)	
CSI0_LN0_N	72	AI	CAMERA MIPI data0 signal (-)	
CSI0_LN0_P	73	AI	CAMERA MIPI data0 signal (+)	
MCAM_MCLK	74	DO	Clock signal of camera	1.85 V voltage domain
SCAM_MCLK	75	DO	Clock signal of camera	1.85 V voltage domain Can be used as ordinary GPIO
MCAM_RST	79	DO	Reset signal of camera	
MCAM_PWDN	80	DO	Power down signal of camera	
SCAM_RST	81	DO	Reset signal of camera	
SCAM_PWDN	82	DO	Power down signal of camera	
CAM_I2C_SCL	83	OD	I2C clock signal of camera	
CAM_I2C_SDA	84	OD	I2C clock signal of camera	

The following is a reference circuit design for cameras.

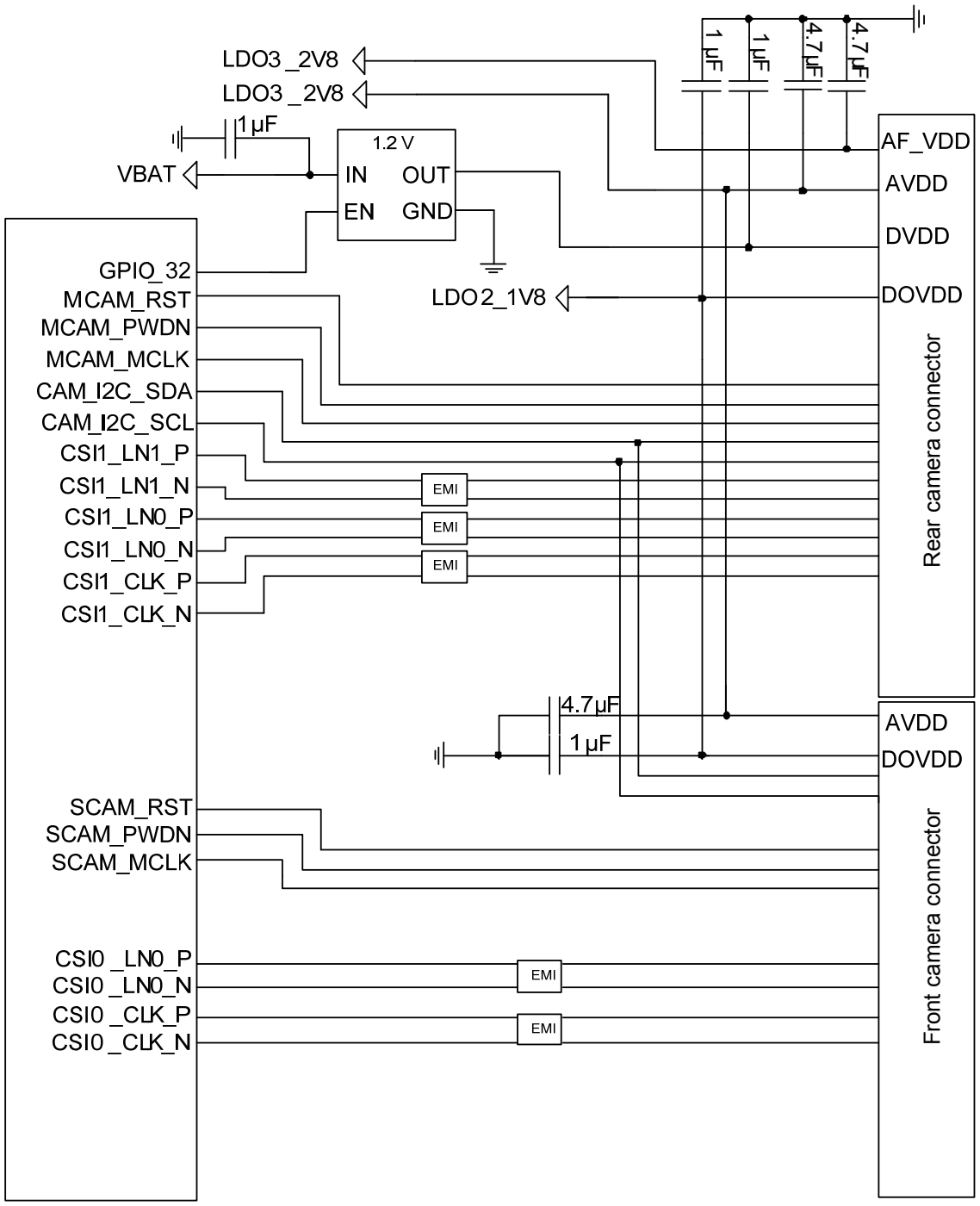


Figure 20: Reference Circuit Design for Cameras

NOTE

CSI1 is used for the rear camera, and CSI0 is used for the front camera.

Design considerations:

- Special attention should be paid to the pin definition of LCM/camera connectors. Assure the SC200L and the connectors are correctly connected .
- MIPI is high speed signal lines, supporting maximum data rate up to 1.5Gbps. The differential impedance should be controlled to 100Ω. Additionally, it is recommended to route the trace on the inner layer of PCB, and do not cross it with other traces. For the same group of DSI or CSI signals, all the MIPI traces should keep the same length. In order to avoid crosstalk, a distance of 1.5 times the trace width among MIPI signal lines is recommended. During impedance matching, do not connect GND on different planes so as to ensure impedance consistency.
- It is recommended to select a low capacitance TVS for ESD protection and the recommended parasitic capacitance should be below 1pF.
- Route MIPI traces according to the following rules:
  a) The total trace length should not exceed 75mm;
  b) Control the differential impedance to 100Ω ±10%;
  c) Control intra-lane length difference within 0.5mm;
  d) Control inter-lane length difference within 1.3 mm.

Table 1: MIPI Trace Length Inside the Module

Pin Name	Pin No	Length (mm)	Length Difference (P-N)
52	DSI_CLK_N	53.88	0.03
53	DSI_CLK_P	53.91	
54	DSI_LN0_N	54.05	-0.36
55	DSI_LN0_P	53.69	
56	DSI_LN1_N	52.10	-0.08
57	DSI_LN1_P	52.02	
58	DSI_LN2_N	55.63	-0.18
59	DSI_LN2_P	55.45	
60	DSI_LN3_N	55.39	-0.45
61	DSI_LN3_P	55.84	
63	CSI1_CLK_N	16.03	-0.09
64	CSI1_CLK_P	15.94	
65	CSI1_LN0_N	14.36	-0.36
66	CSI1_LN0_P	14.00	

67	CSI1_LN1_N	17.46	0.37
68	CSI1_LN1_P	17.83	
70	CSI0_CLK_N	18.24	-0.44
71	CSI0_CLK_P	17.80	
72	CSI0_LN0_N	18.64	0.15
73	CSI0_LN0_P	18.79	

3.19. Sensor Interfaces

SC200L module supports communication with sensors via I2C interfaces, and it supports ALS/PS, compass, G-sensor, and gyroscopic sensors.

Table 22: Pin Definition of Sensor Interfaces

Pin Name	Pin No	I/O	Description	Comment
SENSOR_I2C_SCL	91	OD	I2C clock signal for external sensor	1.85 V voltage domain Can be used for other I2C devices,Can be used as ordinary GPIO
SENSOR_I2C_SDA	92	OD	I2C data signal for external sensor	
GPIO_52	107	DI	Light sensor interrupt signal	
GPIO_54	109	DI	Compass sensor interrupt signal	
GPIO_55	110	DI	Accelerate sensor interrupt signal	
GPIO_53	108	DI	Gyroscope sensor interrupt signal	

3.20. Audio Interface

SC200L module provides three analog input channels and three analog output channels. The following table shows the pin definition.

Table 23: Pin Definition of Audio Interfaces

Pin Name	Pin No	I/O	Description	Comment
MIC1_P	4	AI	Main microphone input (+)	
MIC1_N	5	AI	MIC reference ground	
MIC2_P	6	AI	Headphone microphone input (+)	
MIC2_N	148	AI	Headphone microphone input (-)	
MIC_BIAS2	149	PO	Microphone bias voltage 2	
MIC3_P	152	AI	Secondary microphone input (+)	
MIC3_N	151	AI	Secondary microphone input (-)	
MIC_BIAS1	147	PO	Microphone bias voltage 1	
EAR_P	8	AO	Earpiece output (+)	
EAR_N	9	AO	Earpiece output (-)	
SPK_P	10	AO	Speaker output (+)	
SPK_N	11	AO	Speaker output (-)	
HPH_R	136	AO	Headphone right channel output	
HPH_REF	137	AO	Headphone reference ground	No need to connect to ground
HPH_L	138	AO	Headphone left channel output	
HS_DET	139	AI	Headset insertion detection	The default is high
HPMIC_DET	150	AI	Headphone microphone detection	

- The module has three sets of audio inputs, including three sets of differential input channels
- The output voltage range of two MIC_BIAS is programmable between 2.2V and 3.0V, and the

maximum output current is 2mA.

- The earpiece interface uses differential output.
- The loudspeaker interface uses the differential output as well. The output channel is available with a Class-D amplifier whose output power is 0.8W when load is 8Ω.
- The headphone interface features stereo left and right channel output, and headphone insert detection function is supported.

3.20.1 Microphone interface reference circuit

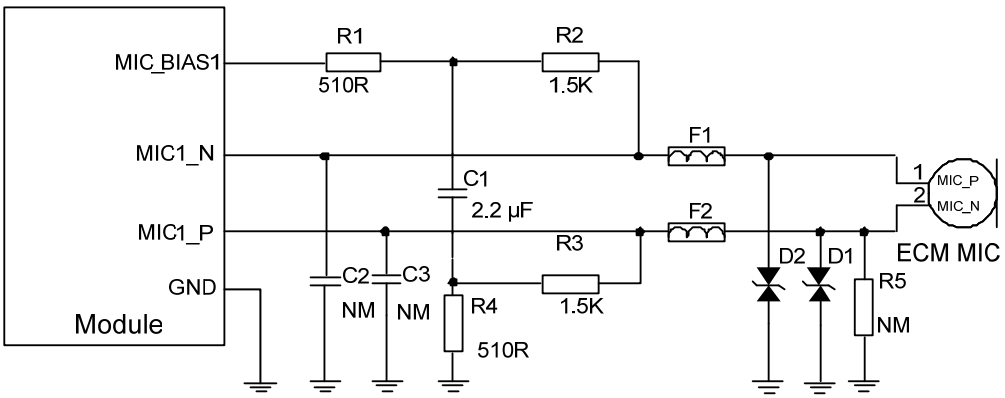


Figure 21: Main microphone reference circuit

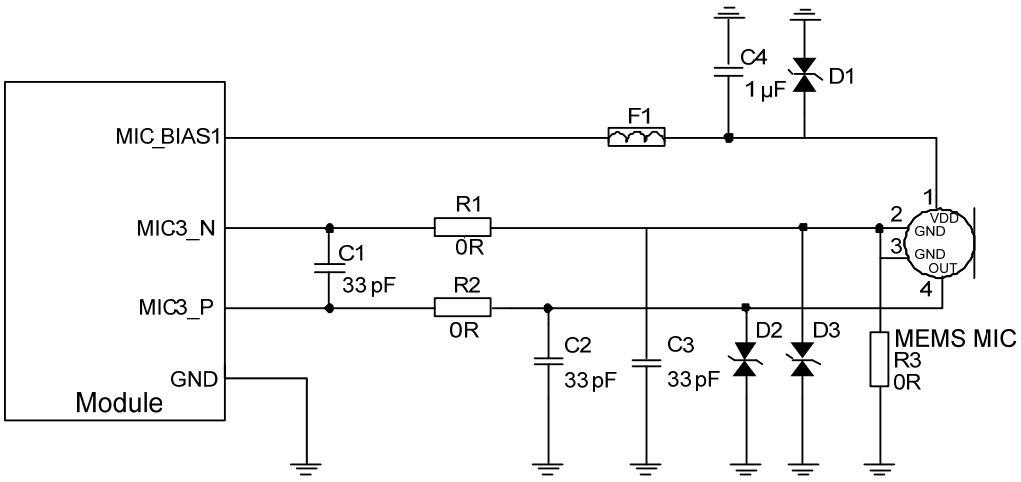


Figure 22: Auxiliary microphone reference circuit

3.20.2 Handset interface reference circuit

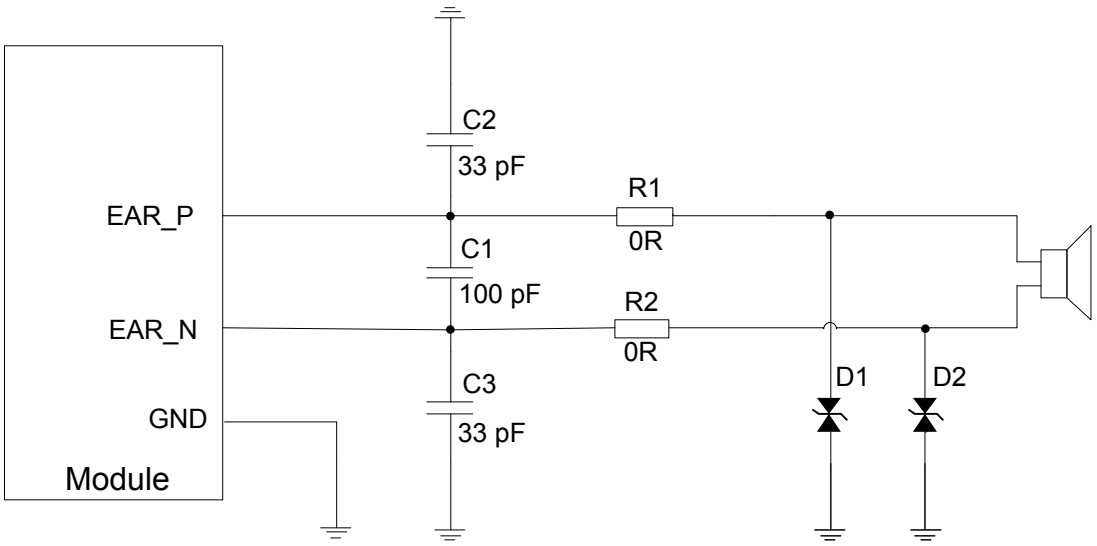


Figure 23: Earpiece output interface reference circuit

3.20.3 Headphone interface reference circuit

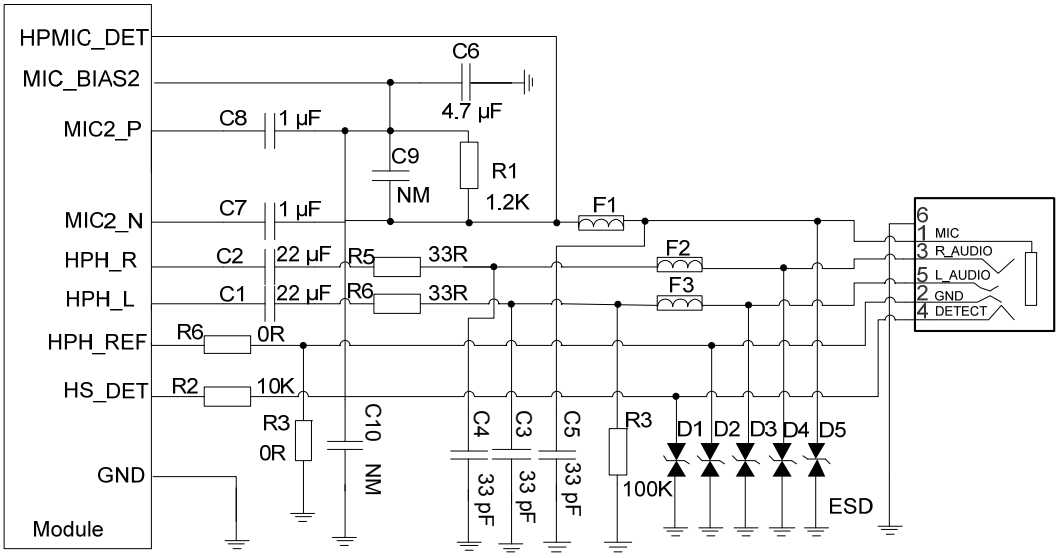


Figure 24: Headphone interface reference circuit

3.20.4 Speaker interface reference circuit

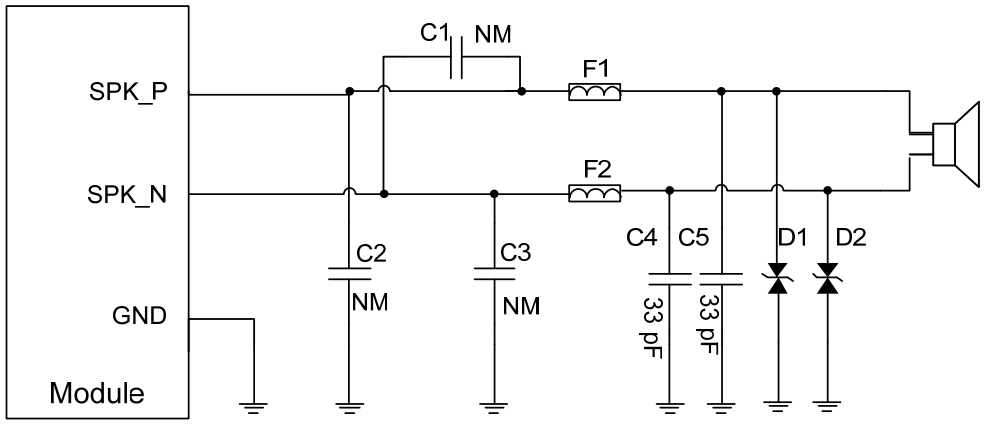


Figure 25: Speaker interface reference circuit

3.20.5 Audio signal design considerations

It is recommended to use the electret microphone with dual built-in capacitors (e.g. 10pF and 33pF) for filtering out RF interference, thus reducing TDD noise. The 33pF capacitor is applied for filtering out RF interference when the module is transmitting at EGSM900. Without placing this capacitor, TDD noise could be heard. The 10pF capacitor here is used for filtering out RF interference at DCS1800. Please note that the resonant frequency point of a capacitor largely depends on the material and production technique. Therefore, customers would have to discuss with their capacitor vendors to choose the most suitable capacitor for filtering out high-frequency noises.

The severity degree of the RF interference in the voice channel during GSM transmitting largely depends on the application design. In some cases, EGSM900 TDD noise is more severe; while in other cases, DCS1800 TDD noise is more obvious. Therefore, a suitable capacitor should be selected based on the test results. Sometimes, even no RF filtering capacitor is required.

In order to decrease radio or other signal interference, RF antennas should be placed away from audio interfaces and audio traces. Power traces cannot be parallel with and also should be far away from the audio traces.

The differential audio traces must be routed according to the differential signal layout rule.

3.21. Emergency Download Interface

USB_BOOT is an emergency download interface. Pull the pin to ground during power-up will force the module to enter emergency download mode.There is an emergency option when failures such as abnormal start-up or running occur. For the convenient firmware upgrade and debugging in the future, please reverse this pin. The reference circuit design is shown below.

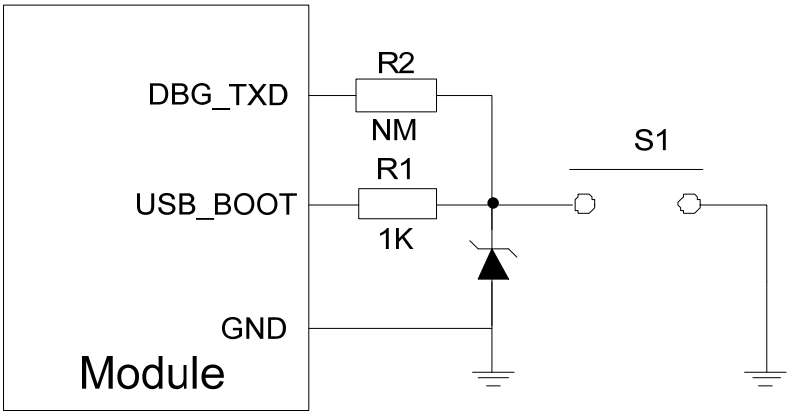


Figure 26: Reference Circuit Design for Emergency Download Interface

4 Wi-Fi and BT

SC200L provides a shared antenna interface ANT_WIFI/BT for Wi-Fi and Bluetooth (BT) functions. The interface impedance is 50Ω. External antennas such as PCB antenna, sucker antenna, and ceramic antenna can be connected to the module via the interface, so as to achieve Wi-Fi and BT functions.

4.1. Wi-Fi Overview

SC200L supports 2.4GHz band WLAN wireless communication based on IEEE 802.11 b/g/n standard protocols. The maximum data rate is up to 72.2Mbps. The features are as below

- Support Wake-on-WLAN (WoWLAN)
- Support ad hoc mode
- Support WAPI SMS4 hardware encryption
- Support AP mode
- Support Wi-Fi Direct
- Support MCS 0-7 for HT20

4.1.1 Wi-Fi Performance

The following table lists the Wi-Fi transmitting and receiving performance of the SC200L module.：

Table 2: Wi-Fi Transmitting Performance

	Standard	Rate	Output Power
2.4 GHz	802.11b	1 Mbps	16 dBm ±2.5 dB
	802.11b	11 Mbps	16 dBm ±2.5 dB
	802.11g	6 Mbps	15 dBm ±2.5 dB
	802.11g	54 Mbps	14 dBm ±2.5 dB
	802.11n HT20	MCS0	15 dBm ±2.5 dB
	802.11n HT20	MCS7	13 dBm ±2.5 dB

Table 3: Wi-Fi Receiving Performance

	Standard	Rate	Sensitivity
2.4 GHz	802.11b	1 Mbps	-89
	802.11b	11 Mbps	-85
	802.11g	6 Mbps	-89
	802.11g	54 Mbps	-74
	802.11n HT20	MCS0	-88
	802.11n HT20	MCS7	-69

Referenced specifications are listed below:：

- IEEE 802.11n WLAN MAC and PHY, October 2009 + IEEE 802.11-2007 WLAN MAC and PHY, June 2007
- IEEE Std 802.11b, IEEE Std 802.11d, IEEE Std 802.11e, IEEE Std 802.11g, IEEE Std 802.11i: IEEE 802.11-2007 WLAN MAC and PHY, June 2007

4.2 BT Overview

SC200L module supports BT4.2 (BR/EDR+BLE) specification, as well as GFSK, 8-DPSK, π/4-DQPSK modulation modes.

- Maximally support up to 7 wireless connections.
- Maximally support up to 3.5 PICONETs at the same time.
- Support one SCO (Synchronous Connection Oriented) or eSCO connection.

The BR/EDR channel bandwidth is 1MHz, and can accommodate 79 channels.

Table 27: BT Data Rate and Version

Version	Data rate	Maximum Application Throughput	Comment
1.2	1 Mbit/s	> 80 Kbit/s	
2.0+EDR	3 Mbit/s	> 80 Kbit/s	

3.0+HS	24 Mbit/s	Reference 3.0 + HS
4.0	24 Mbit/s	Reference 4.0 LE

Referenced specifications are listed below:：

- Bluetooth Radio Frequency TSS and TP Specification 1.2/2.0/2.0 + EDR/2.1/2.1+ EDR/3.0/3.0 + HS, August 6, 2009
- Bluetooth Low Energy RF PHY Test Specification, RF-PHY.TS/4.0.0, December 15, 2009

4.2.1 BT Performance

Table 28: BT Transmitting and Receiving Performance

Transmitter Performance			
Packet Types	DH5	2-DH5	3-DH5
Transmitting Power	8±2 dB	7±2 dB	7±2 dB
Receiver Performance			
Packet Types	DH5	2-DH5	3-DH5
Receiving Sensitivity	-90	-90	-84

5 GNSS

SC200L integrates a Unisoc GNSS engine (GEN 8C) which supports multiple positioning and navigation systems including GPS, GLONASS, and BeiDou. With an embedded LNA, the module provides greatly improved positioning accuracy.

5.1 GNSS Performance

The following table lists the GNSS performance of the SC200L module in conduction mode.

Table 29: GNSS Performance

Parameter	Description	Typ.	Unit
Sensitivity (GNSS)	Cold start	-147	dBm
	Reacquisition	-156	dBm
	Tracking	-156	dBm
TTFF (GNSS)	Cold start	30	s
	Warm start	23	s
	Hot start	5	s
Static Drift (GNSS)	CEP-50	<2.5	m

Note

SC200L-WF NOT SUPPORT GNSS。

5.2 GNSS RF Design Guidelines

Bad design of antenna and layout may cause reduced GPS receiving sensitivity, longer GPS positioning time, or reduced positioning accuracy. In order to avoid this, please follow the reference design rules as below:

6 Maximize the distance between the GNSS RF part and the GPRS RF part (including trace routing and antenna layout) to avoid mutual interference.
7 In user systems, GNSS RF signal lines and RF components should be placed far away from high-speed circuits, switched-mode power supplies, power inductors, the clock circuit of single-chip microcomputers, etc.
8 For applications with a harsh electromagnetic environment or with high requirement on ESD protection, it is recommended to add ESD protection diodes for the antenna interface. Only diodes with ultra-low junction capacitance such as 0.5pF can be selected. Otherwise, there will be effects on the impedance characteristic of the RF circuit loop or attenuation of the bypass RF signal may be caused.
9 Control the impedance of either feeder line or PCB trace to 50Ω, and keep the trace length as short as possible.
10 Refer to ***Chapter 6.3*** for the GNSS reference circuit design.

6 Antenna Interfaces

SC200L provides four antenna interfaces for the main antenna, Rx-diversity/MIMO antenna, GNSS antenna and Wi-Fi/BT antenna, respectively. The antenna ports have an impedance of 50Ω.

6.1 Main/Rx-diversity Antenna Interfaces

The pin definition of main/Rx-diversity antenna interfaces is shown below. :

Table30: Pin Definition of Main/Rx-diversity Antenna Interfaces

Pin Name	Pin No.	I/O	Description	Comment
ANT_MAIN	87	IO	Main antenna	50Ω impedance
ANT_DRX	131	AI	Diversity antenna	

The operating frequencies of SC200L are listed in the following tables

Table31: SC200L-CE Operating Frequencies

3GPP Band	Receive	Transmit	Unit
EGSM900	925~960	880~915	MHz
DCS1800	1805~1880	1710~1785	MHz
WCDMA B1	2110~2170	1920~1980	MHz
WCDMA B8	925~960	880~915	MHz
LTE-FDD B1	2110~2170	1920~1980	MHz
LTE-FDD B3	1805~1880	1710~1785	MHz
LTE-FDD B5	869~894	824~849	MHz

LTE-FDD B8	925~960	880~915	MHz
LTE-TDD B34	2010~2025	2010~2025	MHz
LTE-TDD B38	2570~2620	2570~2620	MHz
LTE-TDD B39	1880~1920	1880~1920	MHz
LTE-TDD B40	2300~2400	2300~2400	MHz
LTE-TDD B41	2535~2675	2535~2675	MHz

Table32: SC200L-EM* Operating Frequencies

3GPP Band	Receive	Transmit	Unit
GSM850	869~894	824~849	MHz
EGSM900	925~960	880~915	MHz
DCS1800	1805~1880	1710~1785	MHz
PCS1900	1930~1990	1850~1910	MHz
WCDMA B1	2110~2170	1920~1980	MHz
WCDMA B2	1930~1990	1850~1910	MHz
WCDMA B5	869~894	824~849	MHz
WCDMA B8	925~960	880~915	MHz
LTE-FDD B1	2110~2170	1920~1980	MHz
LTE-FDD B2	1930~1990	1850~1910	MHz
LTE-FDD B3	1805~1880	1710~1785	MHz
LTE-FDD B5	869~894	824~849	MHz
LTE-FDD B7	2620~2690	2500~2570	MHz
LTE-FDD B8	925~960	880~915	MHz
LTE-FDD B20	791~821	832~862	MHz
LTE-FDD B28(A + B)	758~803	703~748	MHz

LTE-TDD B38	2570~2620	2570~2620	MHz
LTE-TDD B39	1880~1920	1880~1920	MHz
LTE-TDD B40	2300~2400	2300~2400	MHz
LTE-TDD B41	2496~2690	2496~2690	MHz

NOTE

"*" means under development.

6.1.1 Main and Rx-diversity Antenna Interfaces Reference Design

A reference circuit design for main and Rx-diversity antenna interfaces is shown as below. A π-type matching circuit should be reserved for better RF performance. The π-type matching components (R1/C1/C2, R2/C3/C4) should be placed as close to the antennas as possible and are mounted according to the actual debugging. The C1, C2, C3, and C4 are not mounted and a 0Ω resistor is mounted on R1 and R2 respectively by default.

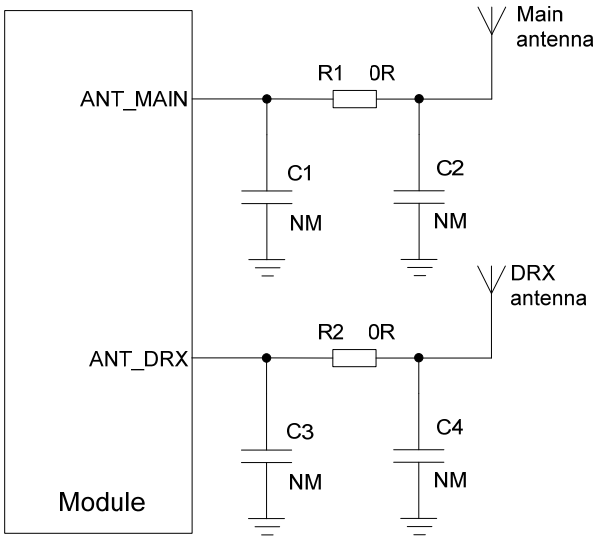


Figure 27: Reference Circuit Design for Main and Rx-diversity Antenna Interfaces

6.1.2 Reference Design of RF Layout

For user's PCB, the characteristic impedance of all RF traces should be controlled to 50Ω. The impedance of the RF traces is usually determined by the trace width (W), the materials' dielectric constant,

height from the reference ground to the signal layer (H), and the clearance between RF traces and grounds (S). Microstrip or coplanar waveguide is typically used in RF layout to control characteristic impedance. The following are reference designs of microstrip line or coplanar waveguide with different PCB structures.

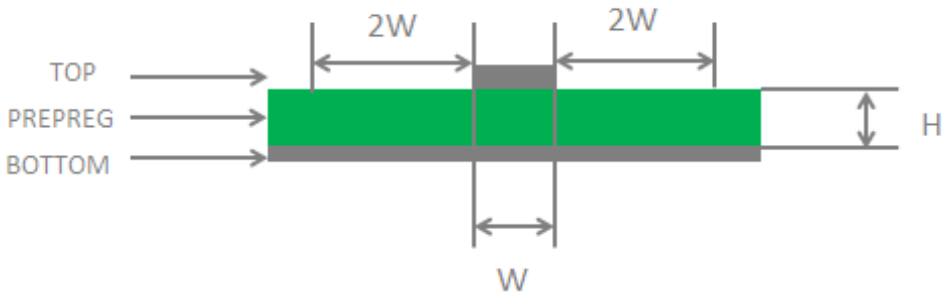


Figure 27: Microstrip Design on a 2-layer PCB

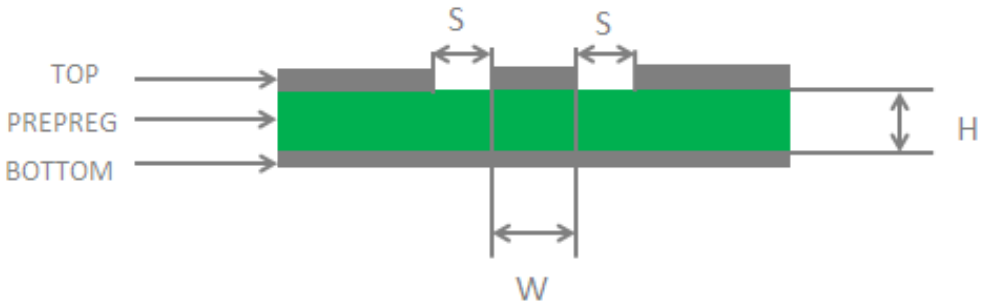


Figure 28: Coplanar Waveguide Design on a 2-layer PCB

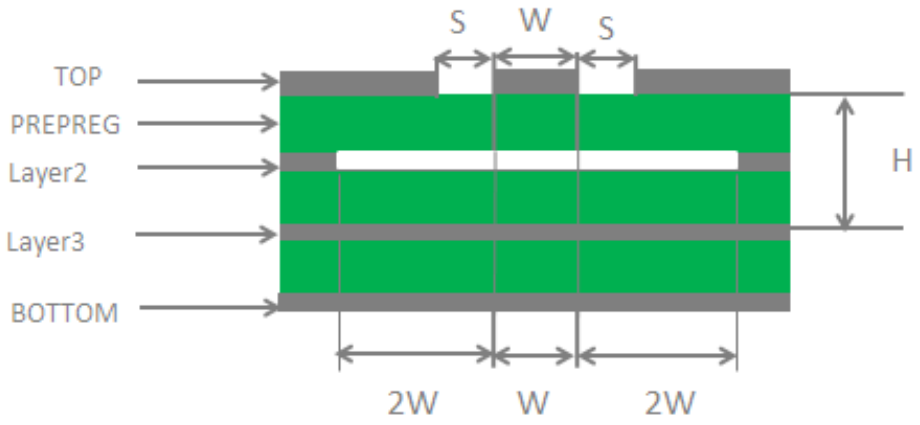


Figure 29: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

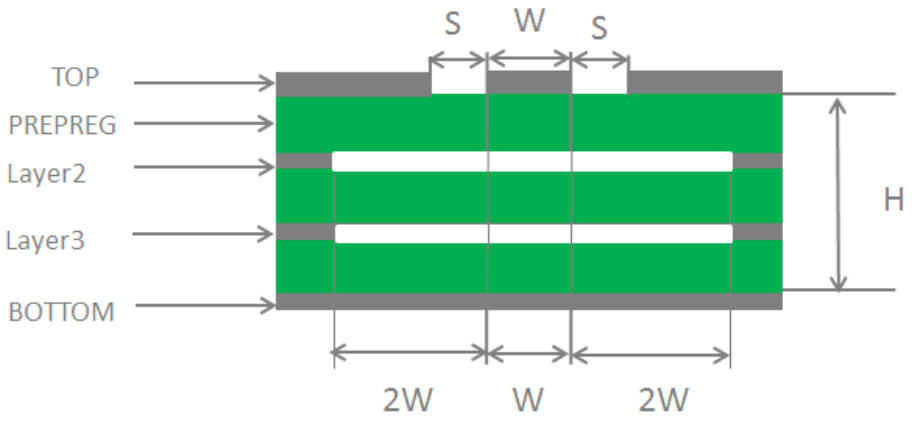


Figure 30: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

In order to ensure RF performance and reliability, the following principles should be complied with in RF layout design:

- Use an impedance simulation tool to accurately control the characteristic impedance of RF traces to 50Ω.
- The GND pins adjacent to RF pins should not be designed as thermal relief pads, and should be fully connected to ground.
- The distance between the RF pins and the RF connector should be as short as possible, and all the right-angle traces should be changed to curved ones.
- There should be clearance under the signal pin of the antenna connector or solder joint.
- The reference ground of RF traces should be complete. Meanwhile, adding some ground vias around RF traces and the reference ground could help to improve RF performance. The distance between the ground vias and RF traces should be no less than two times as wide as RF signal traces (2 x W).

For more details about the RF layout, please refer to the ***document [3]***.

6.2 Wi-Fi/BT Antenna Interface

The following tables show the pin definition and frequency specification of the Wi-Fi/BT antenna interface.

Table 4: Pin Definition of Wi-Fi/BT Antenna Interface

Pin Name	Pin No.	I/O	Description	Comment

ANT_WIFI/BT	77	IO	Wi-Fi/BT antenna interface	50Ω impedance

Table 5: Wi-Fi/BT Frequency

Type	Frequency	Unit
Wi-Fi (2.4GHz)	CE: 2412-2472 MHz FCC: 2412-2462 MHz	MHz
BT4.2 LE	2402~2480	MHz

A reference circuit design for Wi-Fi/BT antenna interface is shown as below. C1 and C2 are not mounted and a 0Ω resistor is mounted on R1 by default.

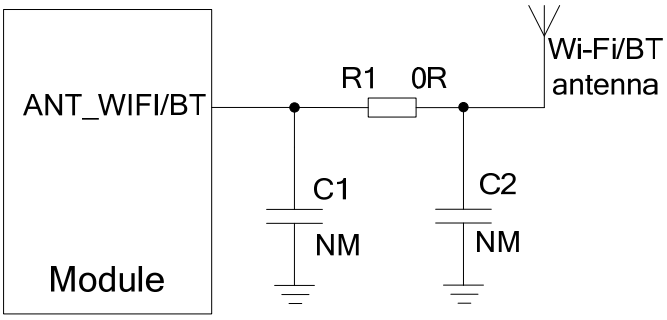


Figure28: Reference Circuit Design for Wi-Fi/BT Antenna

6.3 GNSS Antenna Interface

Table 35: Pin Definition of GNSS Antenna Interface

Pin Name	Pin No.	I/O	Description	Comment
ANT_GNSS	121	AI	GNSS antenna interface	50Ω impedance

Table 36: GNSS Frequency

Type	Frequency	Unit

GPS	1575.42 ±1.023	MHz
GLONASS	1597.5~1605.8	MHz
BeiDou	1561.098 ±2.046	MHz

NOTE

SC200L-WFnot support GNSS。

6.3.1 Recommended Circuit for Passive Antenna

GNSS antenna interface supports passive ceramic antennas and other types of passive antennas. A reference circuit design is given below.

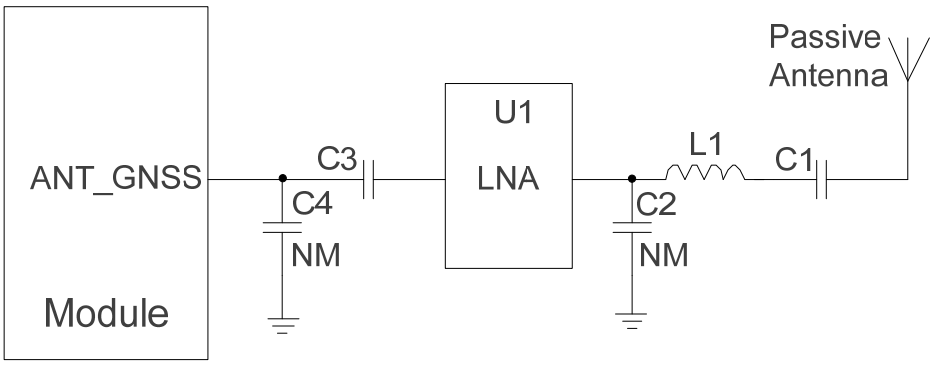


Figure 29: Reference Circuit Design for GNSS Passive Antenna

NOTE

When the passive antenna is placed far away from the module (that is, the antenna trace is long), it is recommended to add an external LNA circuit for better GNSS receiving performance, and the LNA should be placed close to the antenna.

6.3.2 Recommended Circuit for Active Antenna

The active antenna is powered by a 56nH inductor through the antenna's signal path. The common power supply voltage ranges from 3.3V to 5.0V. Although featuring low power consumption, the active antenna still requires stable and clean power supplies. It is recommended to use high-performance LDO as the power supply. A reference design of the GNSS active antenna is shown below.

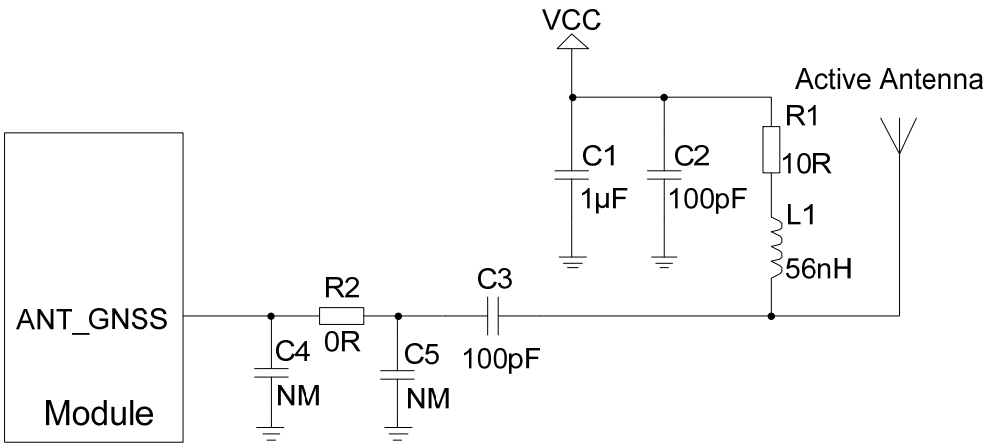


Figure 30: Reference Circuit Design for GNSS Active Antenna

6.4 Antenna Installation

6.4.1 Antenna Requirements

The following table shows the requirement on the main antenna, RX-diversity antenna, Wi-Fi/BT antenna and a GNSS antenna.

Table 37: Antenna Requirements

Type	Requirements
GSM/WCDMA/LTE	VSWR:> ≤ 2 Gain (dBi): 1 Max Input Power (W): 50 Input Impedance (Ω): 50 Polarization Type: Vertical Insertion Loss: < 1dB (GSM850、EGSM900、WCDMA B5/B8、LTE B5/B8/B20/B28A/B28B) Insertion Loss ： < 1.5 dB (DCS1800、PCS1900、WCDMA B1/B2、LTE B1/B2/B3/B34/B39) Insertion Loss ： < 2 dB (LTE-FDD B7、LTE-TDD B38/B40/B41)
Wi-Fi/BT	VSWR: ≤ 2 Gain (dBi): 1 Max Input Power (W): 50 Input Impedance (Ω): 50

	Polarization Type: Vertical Insertion Loss: < 1dB
GNSS	Frequency range: 1559MHz~1609MHz Polarization: RHCP or linear VSWR: < 2 (Typ.) Passive Antenna Gain: > 0dBi Active Antenna Noise Figure: < 1.5dB Active Antenna Total Gain: < 17dBi (Typ.)

6.4.2 Recommended RF Connector for Antenna Installation

If an RF connector is used for antenna connection, it is recommended to use the U.FL-R-SMT connector provided by HIROSE.

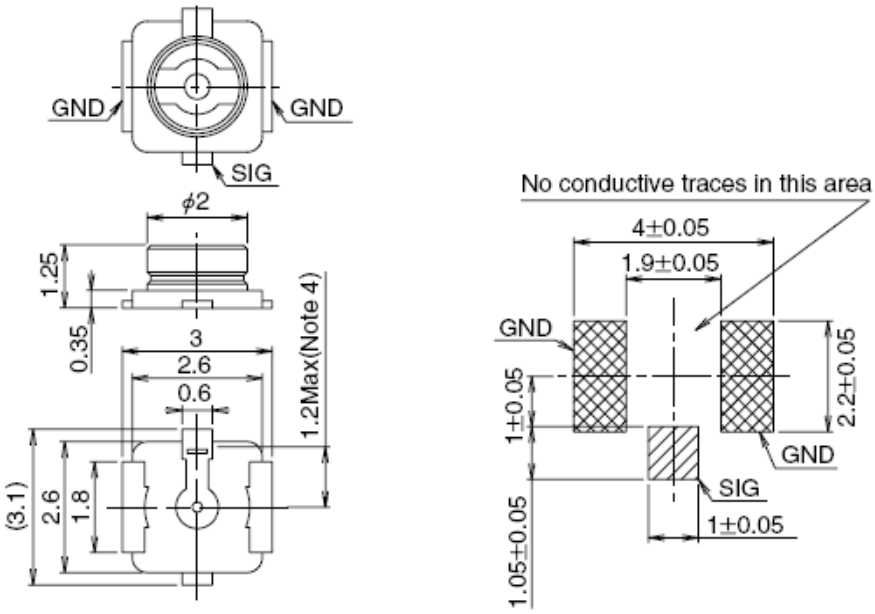


Figure 31: Dimensions of the U.FL-R-SMT Connector (Unit: mm)

U.FL-LP serial connectors listed in the following figure can be used to match the U.FL-R-SMT.

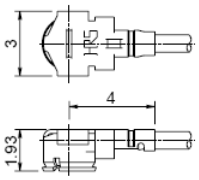
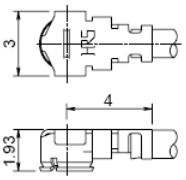
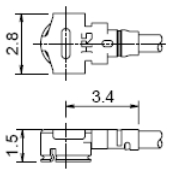
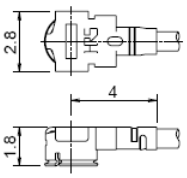
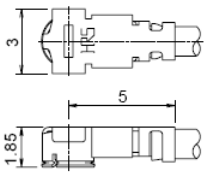
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 0.81mm Coaxial cable	Dia. 1mm Coaxial cable	Dia. 1.37mm Coaxial cable
Weight (mg)	53.7	59.1	34.8	45.5	71.7
RoHS	YES				

Figure 32: Mechanicals of U.FL-LP Connectors

The following figure describes the space factor of mated connector.

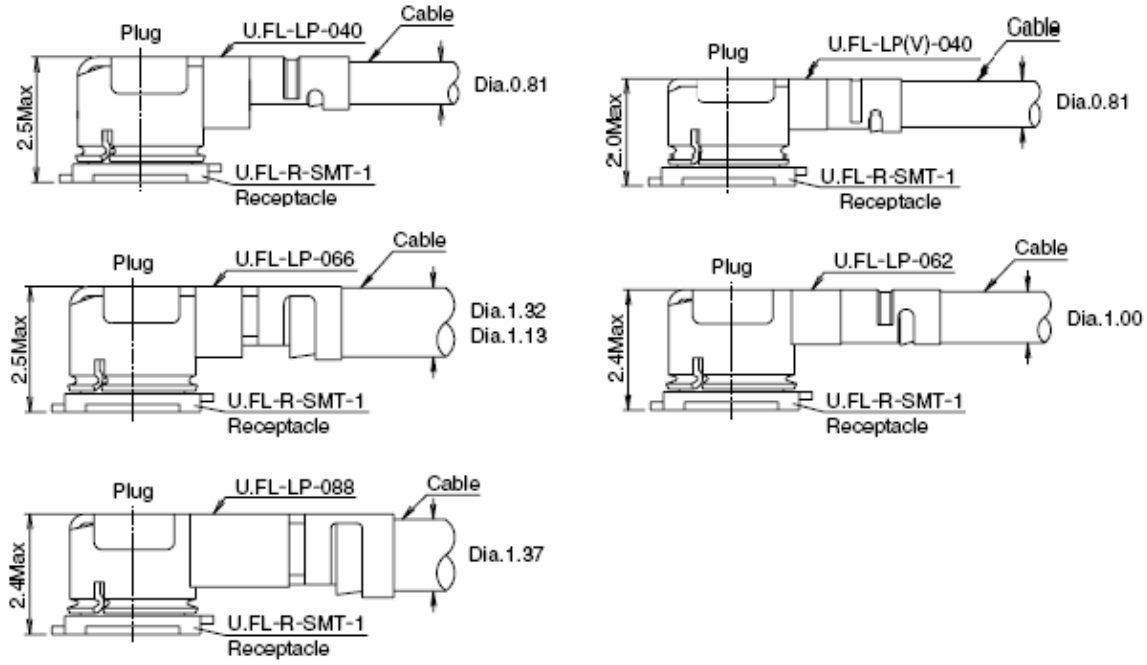


Figure 33: Space Factor of Mated Connectors (Unit: mm)

For more details, please visit http://www.hirose.com。

6 Electrical, Reliability and Radio Characteristics

7.1 Absolute Maximum Ratings

The following table lists the maximum withstand voltage/current of some pins of the module:

Table 6: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
VBAT	-0.3	6.0	V
USB_VBUS	-0.3	16.0	V
Peak Current of VBAT	0	3.0	A
Voltage on Digital Pins	-0.3	1.98	V

7.2 Power Supply Ratings

Table 7: SC200L Module Power Supply Ratings

Parameter	Description	Conditions	Min.	Typ.	Max.	Unit
VBAT	VBAT	The actual input voltages must stay between the minimum and maximum values	3.50	3.80	4.20	V
	Voltage drop during transmitting burst	Maximum power control level at EGSM900			800	mV
I_{VBAT}	Peak supply current (during	Maximum power control level at EGSM900		1.80	3.0	A

	transmission slot)				
USB_VBUS		4.50	5.0	9.20	V

7.3 Operation and Storage Temperatures

The operating temperature is listed in the following table.

Table 8: Operation and Storage Temperatures

Parameter	Min.	Typ.	Max.	Unit
Operating temperature range [1)]	-30	+25	+75	ºC
Storage Temperature Range	-40		+90	ºC

NOTE

[1)] Within the operation temperature range, the module is 3GPP compliant.

7.4 Current Consumption

The values of current consumption are shown below.

Table 9: SC200L-CE Current Consumption

Parameter	Description	Conditions	Min	Typ.
I_{VBAT}	OFF state	Power down	350	μA
	GSM/GPRS supply current	Sleep (USB disconnected) @DRX=2	3.5	mA
		Sleep (USB disconnected) @DRX=5	3	mA
		Sleep (USB disconnected) @DRX=9	3	mA
	WCDMA supply	Sleep (USB disconnected) @DRX=6	4.7	mA

	current	Sleep (USB disconnected) @DRX=7	3.7	mA
		Sleep (USB disconnected) @DRX=8	3.5	mA
		Sleep (USB disconnected) @DRX=9	3	mA
	LTE-FDD supply current	Sleep (USB disconnected) @DRX=5	6.5	mA
		Sleep (USB disconnected) @DRX=6	4.8	mA
		Sleep (USB disconnected) @DRX=7	4.2	mA
		Sleep (USB disconnected) @DRX=9	3.8	mA
	LTE-TDD supply current	Sleep (USB disconnected) @DRX=5	6.2	mA
		Sleep (USB disconnected) @DRX=6	4.8	mA
		Sleep (USB disconnected) @DRX=7	4.2	mA
		Sleep (USB disconnected) @DRX=9	3.8	mA
	GSM voice call	EGSM900 @ PCL 5	260	mA
		EGSM900 @ PCL 12	125	mA
		EGSM900 @ PCL 19	90	mA
		DCS1800 @ PCL 0	200	mA
		DCS1800 @ PCL 7	115	mA
		DCS1800 @ PCL 15	85	mA
	WCDMA voice call	B1 @ max power	620	mA
		B8 @ max power	580	mA
	GPRS data transfer	EGSM900 (1UL/4DL) @ PCL 5	250	mA
		EGSM900 (2UL/3DL) @ PCL 5	380	mA
		EGSM900 (3UL/2DL) @ PCL 5	425	mA
		EGSM900 (4UL/1DL) @ PCL 5	470	mA
		DCS1800 (1UL/4DL) @ PCL 0	190	mA
		DCS1800 (2UL/3DL) @ PCL 0	260	mA

		DCS1800 (3UL/2DL) @ PCL 0	305	mA
		DCS1800 (4UL/1DL) @ PCL 0	330	mA
	EDGE data transfer	EGSM900 (1UL/4DL) @ PCL 8	325	mA
		EGSM900 (2UL/3DL) @ PCL 8	580	mA
		EGSM900 (3UL/2DL) @ PCL 8	860	mA
		EGSM900 (4UL/1DL) @ PCL 8	730	mA
		DCS1800 (1UL/4DL) @ PCL 2	230	mA
		DCS1800 (2UL/3DL) @ PCL 2	370	mA
		DCS1800 (3UL/2DL) @ PCL 2	435	mA
		DCS1800 (4UL/1DL) @ PCL 2	450	mA
	WCDMA data transfer	B1 (HSDPA) @ max power	620	mA
		B8 (HSDPA) @ max power	530	mA
		B1 (HSUPA) @ max power	520	mA
		B8 (HSUPA) @ max power	500	mA
	LTE data transfer	LTE-FDD B1 @ max power	670	mA
		LTE-FDD B3 @ max power	670	mA
		LTE-FDD B5 @ max power	510	mA
		LTE-FDD B8 @ max power	590	mA
		LTE-TDD B34 @ max power	290	mA
		LTE-TDD B38 @ max power	240	mA
		LTE-TDD B39 @ max power	234	mA
		LTE-TDD B40 @ max power	370	mA
		LTE-TDD B41 @ max power	440	mA

Table 10: SC200L-EM Current Consumption

Parameter	Description	Conditions	Min	Typ.
I_{VBAT}	OFF state	Power down	350	μA

7.5 RF Output Power

The following table shows the RF output power of SC200L module.

Table 41: SC200L-CE RF Output Power

Frequency	Max.	Min.
EGSM900	33 dBm ±2 dB	5 dBm ±5 dB
DCS1800	30 dBm ±2 dB	0 dBm ±5 dB
WCDMA B1	24 dBm +1/-3 dB	< -49 dBm
WCDMA B8	24 dBm +1/-3 dB	< -49 dBm
LTE-FDD B1	23 dBm ±2 dB	< -39 dBm
LTE-FDD B3	23 dBm ±2 dB	< -39 dBm
LTE-FDD B5	23 dBm ±2 dB	< -39 dBm
LTE-FDD B8	23 dBm ±2 dB	< -39 dBm
LTE-TDD B34	23 dBm ±2 dB	< -39 dBm
LTE-TDD B38	23 dBm ±2 dB	< -39 dBm
LTE-TDD B39	23 dBm ±2 dB	< -39 dBm
LTE-TDD B40	23 dBm ±2 dB	< -39 dBm
LTE-TDD B41	23 dBm ±2 dB	< -39 dBm

Table 42: SC200L-EM RF Output Power

Frequency	Max.	Min.
GSM850	33 dBm ±2 dB	5 dBm ±5 dB
EGSM900	33 dBm ±2 dB	5 dBm ±5 dB
DCS1800	30 dBm ±2 dB	0 dBm ±5 dB
PCS1900	30 dBm ±2 dB	0 dBm ±5 dB
WCDMA B1	24 dBm +1/-3 dB	< -49 dBm
WCDMA B2	24 dBm +1/-3 dB	< -49 dBm
WCDMA B5	24 dBm +1/-3 dB	< -49 dBm
WCDMA B8	24 dBm +1/-3 dB	< -49 dBm
LTE-FDD B1	23 dBm ±2 dB	< -39 dBm
LTE-FDD B2	23 dBm ±2 dB	< -39 dBm
LTE-FDD B3	23 dBm ±2 dB	< -39 dBm
LTE-FDD B5	23 dBm ±2 dB	< -39 dBm
LTE-FDD B7	23 dBm ±2 dB	< -39 dBm
LTE-FDD B8	23 dBm ±2 dB	< -39 dBm
LTE-FDD B20	23 dBm ±2 dB	< -39 dBm
LTE-FDD B28(A + B)	23 dBm ±2 dB	< -39 dBm
LTE-TDD B38	23 dBm ±2 dB	< -39 dBm
LTE-TDD B39	23 dBm ±2 dB	< -39 dBm
LTE-TDD B40	23 dBm ±2 dB	< -39 dBm
LTE-TDD B41	23 dBm ±2 dB	< -39 dBm

NOTE

1. In GPRS 4 slots TX mode, the maximum output power is reduced by 3dB. This design conforms to the GSM specification as described in ***Chapter 13.16*** of *3GPP TS 51.010-1*.

2. “*” means under development.

7.6 RF Receiving Sensitivity

The following table shows the RF receiving sensitivity of SC200L module.

Table 44: SC200L-EM RF Receiving Sensitivity

Frequency	Primary	Diversity	SIMO	3GPP (SIMO)
GSM850	-108	/	/	-102.4 dBm
EGSM900	-108	/	/	-102.4 dBm
DCS1800	-108	/	/	-106.7 dBm
PCS1900	-107	/	/	-103.7 dBm
WCDMA B1	-108	-110	/	-104 dBm
WCDMA B2	-107.5	-109.5	/	-108 dBm
WCDMA B5	-111	-111.5	/	-108 dBm
WCDMA B8	-109.5	-111	/	-96.3 dBm
LTE-FDD B1 (10 MHz)	-98	-99	-101.5	-93.3 dBm
LTE-FDD B2 (10 MHz)	-97	-98.3	-99.6	-94.3 dBm
LTE-FDD B3 (10 MHz)	-98.1	-98.7	-101	-93.3 dBm
LTE-FDD B5 (10 MHz)	-100	-101	-103	-96.3 dBm
LTE-FDD B7 (10 MHz)	-96.5	-99	-101.4	-96.3 dBm
LTE-FDD B8 (10 MHz)	-98	-100.6	-102.5	-96.3 dBm
LTE-FDD B20 (10 MHz)	-99.4	-96.6	101.5	-96.3 dBm
LTE-FDD B28 (10 MHz)	-99.4	-97.2	-101.5	-94.3 dBm
LTE-TDD B38 (10 MHz)	-97.1	-98.3	-100.6	-94.3 dBm
LTE-TDD B39 (10 MHz)	-98.4	-97.6	-102.4	-96.3 dBm

LTE-TDD B40 (10 MHz)	-97.4	-98.9	-100.9	-96.3 dBm
LTE-TDD B41 (10 MHz)	-96.2	-97.5	-100.2	-94.3 dBm

NOTE

"*" means under development.

7.7 Electrostatic Discharge

The module is not protected against electrostatic discharge (ESD) in general. Consequently, it should be subject to ESD handling precautions that are typically applied to ESD sensitive components. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates the module.

The following table shows the electrostatic discharge characteristics of SC200L module.

Table 11: ESD Characteristics (Temperature: 25 ºC, Humidity: 45%)

Tested Points	Contact Discharge	Air Discharge	Unit
VBAT, GND	+/-5	+/-10	KV
All Antenna Interfaces	+/-5	+/-10	KV
Other Interfaces	+/-0.5	+/-1	KV

7 Mechanical Dimensions

This chapter describes the mechanical dimensions of the module. All dimensions are measured in millimeter (mm), and the tolerances for dimensions without tolerance values are ±0.05 mm.

8.1 Mechanical Dimensions of the Module

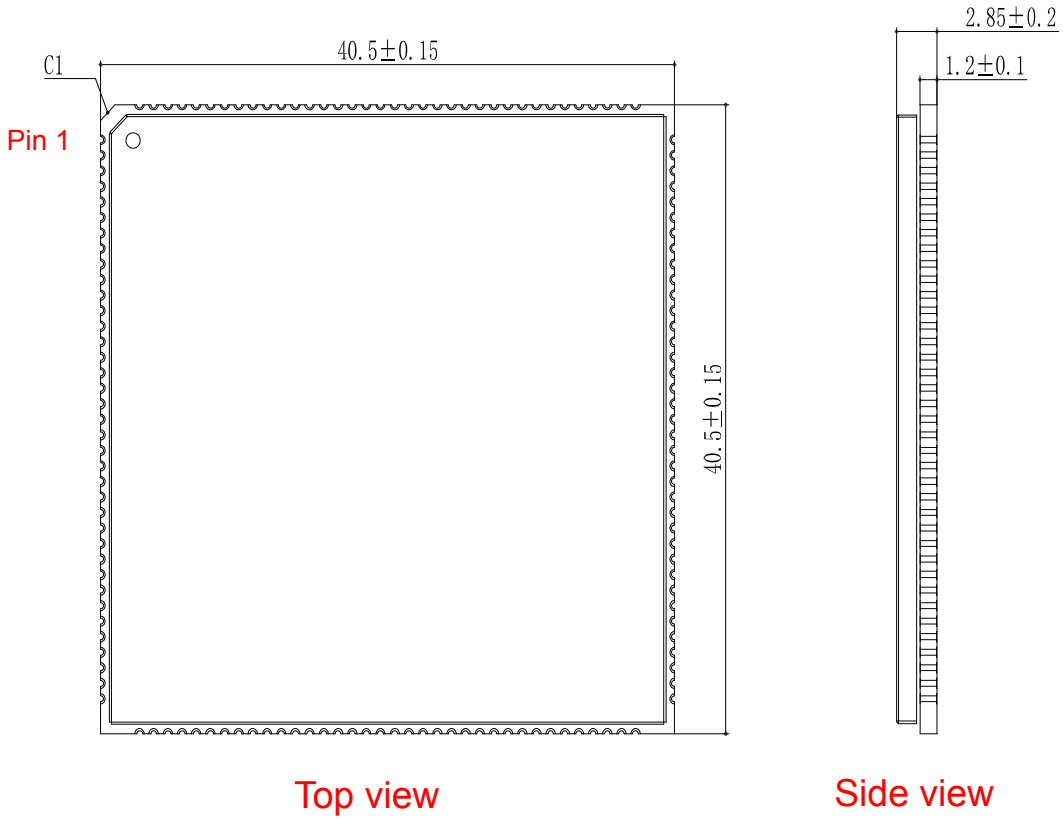


Figure 34: SC200L Module Top and Side Dimensions

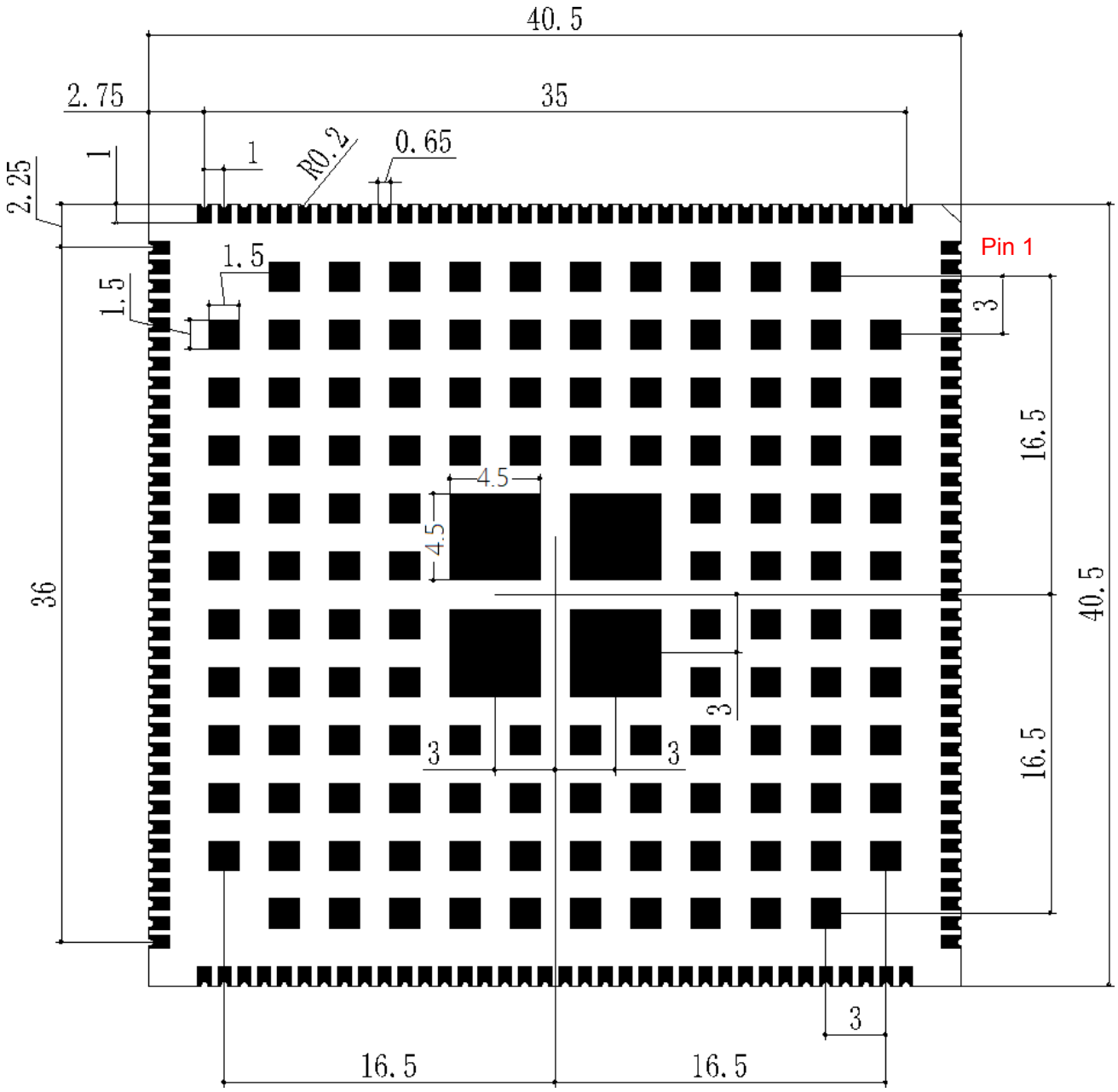


Figure 35: SC200L Module Bottom Dimensions (Top View)

8.2 Recommended Footprint

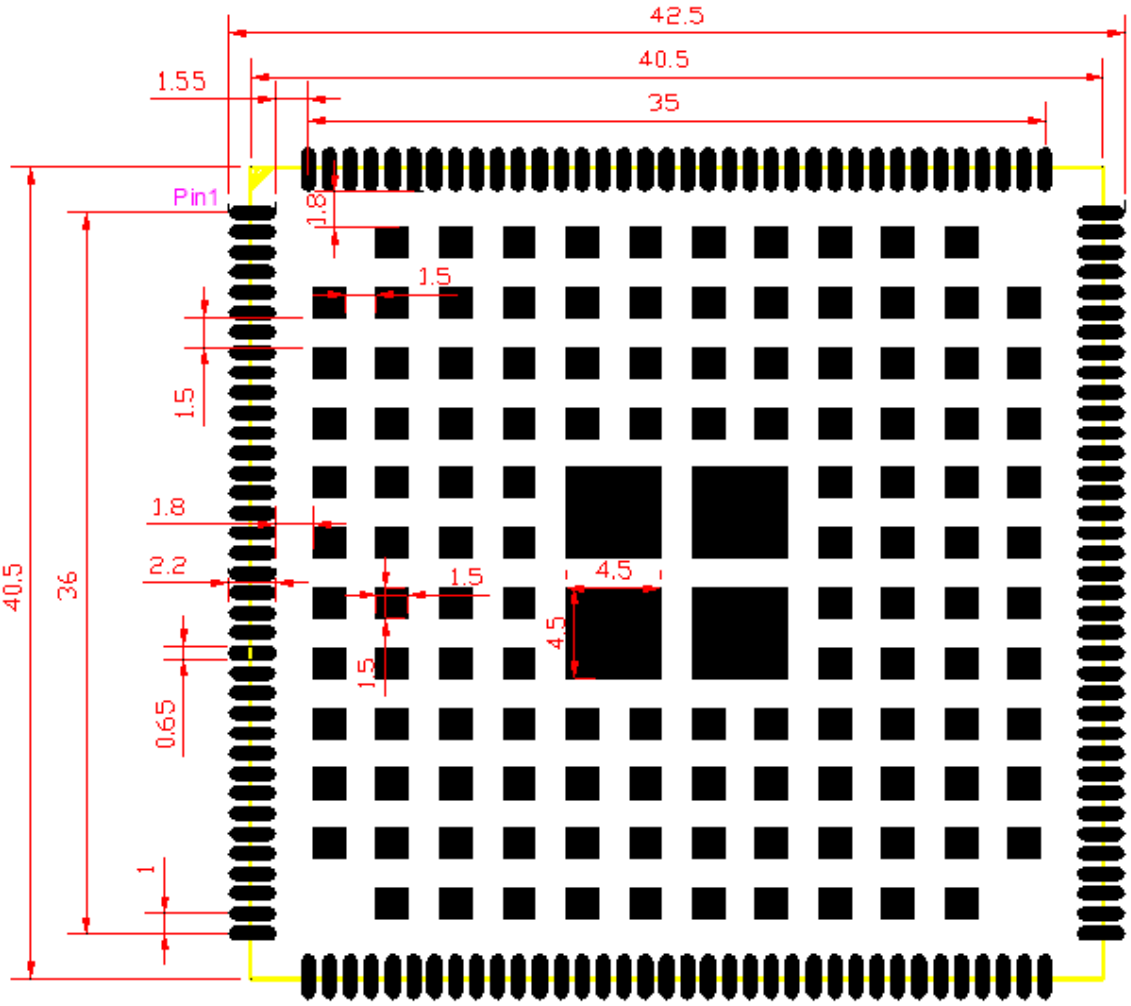


Figure36: Recommended Footprint (Top View)

NOTES

1. For easy maintenance of the module, keep about 5 mm between the module and other components on the host PCB.
2. All RESERVED pins should be kept open and MUST NOT be connected to ground.。

8.3 Top and Bottom Views of the Module

Figure37: Top View of the Module

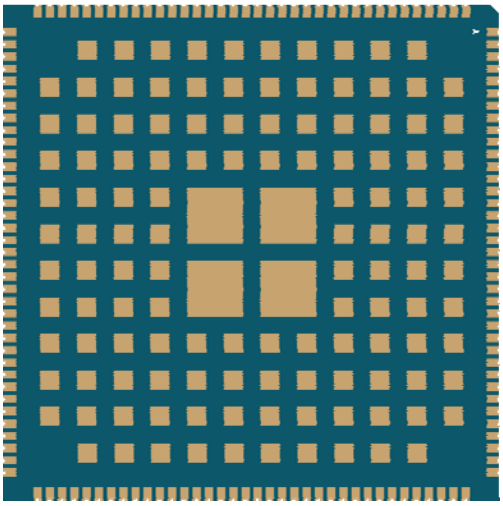


Figure 38: Bottom View of the Module

NOTE

These are renderings of SC200L module. For authentic dimension and appearance, please refer to the module that you receive from Quectel.

8 Storage, Manufacturing and Packaging

8.1 Storage

SC200L is stored in a vacuum-sealed bag. It is rated at MSL 3, and its storage restrictions are shown as below.

1. Recommended storage conditions: temperature 23 ± 5 °C, and relative humidity 35% ~ 60%.储

2. Under the recommended storage conditions, the module can be stored in a vacuum sealed bag for 12 months.

3. Under workshop conditions with a temperature of 23 ±5 °C and a relative humidity of less than 60%, the workshop life of the module after unpacking is 168 hours 1). Under this condition, the module can be directly subjected to reflow production or other high-temperature operations. Otherwise, the module needs to be stored in an environment with a relative humidity of less than 10% (for example, a moisture-proof cabinet) to keep the module dry.

4. If the module is in the following conditions, the module needs to be pre-baked to prevent the PCB from blistering, cracks and delamination after the module absorbs moisture and is then soldered at high temperature:

   - The storage temperature and humidity do not meet the recommended storage conditions
   - The module failed to complete production or storage according to Article 3 above after unpacking;
   - Leakage of vacuum packaging, bulk materials;
   - Before returning the module for repair.

5. Baking treatment of the module:

   - It needs to be baked at a high temperature of 120 ±5 °C for 8 hours;
   - The second-baked module must be soldered within 24 hours after baking, otherwise it still needs to be stored in a dry box.

9.2 Manufacturing and Soldering

Push the squeegee to apply the solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate to the PCB. The force on the squeegee should be adjusted properly so as to produce a clean stencil surface on a single pass. To ensure the module soldering quality, the thickness of stencil for the module is recommended to be 0.18 mm~0.20 mm. It is recommended to slightly reduce the amount of solder paste for LGA pads, thus avoiding short-circuit. For more details, please refer to ***document [5]***.

It is suggested that the peak reflow temperature is 238~246 ºC, and the absolute maximum reflow temperature is 246 ºC. To avoid damage to the module caused by repeated heating, it is strongly recommended that the module should be mounted after reflow soldering for the other side of PCB has been completed. The recommended reflow soldering thermal profile (lead-free reflow soldering) and related parameters are shown below:

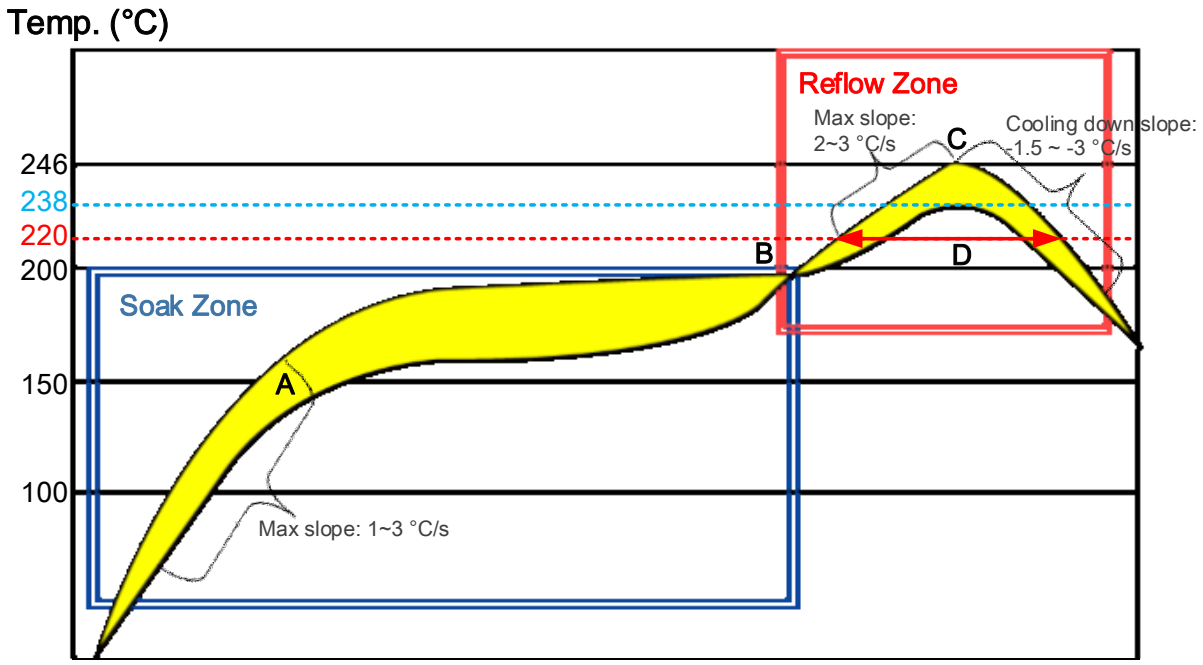


Figure 39: Recommended Reflow Soldering Thermal Profile

Table 12: Recommended Thermal Profile Parameters

Factor	Recommendation
Soak Zone	
Max slope	1 to 3 °C/sec
Soak time (between A and B: 150 °C and 200 °C)	70 to 120 sec
Reflow Zone	

Max slope	2~3 °C/s
Reflow time (D: over 220 °C)	45~70 s
Max temperature	238 °C ~ 246 °C
Cooling down slope	-1.5 ~ -3 °C/s
Reflow Cycle	
Max reflow cycle	1

9.3 Packaging

SC200L is packaged in tape and reel carriers, and sealed in the vacuum-sealed bag. It is not recommended to open the vacuum package before using the module for actual production. Each reel is 380 mm in diameter and contains 200 modules. The following figures show the package details, measured in mm.

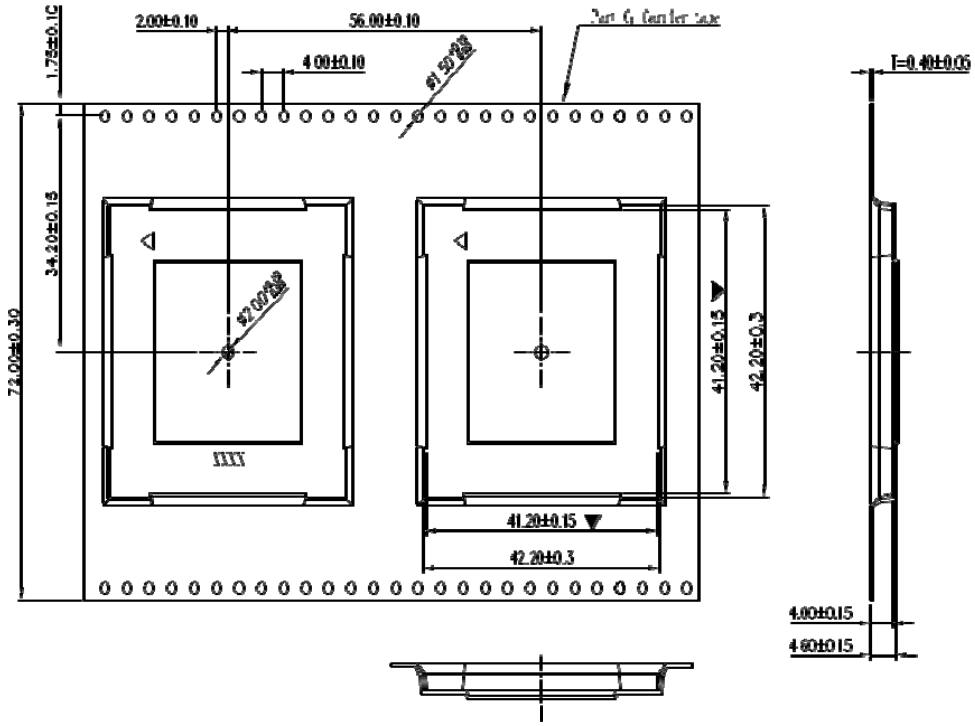


Figure 40: Tape Dimensions（Unit: mm）

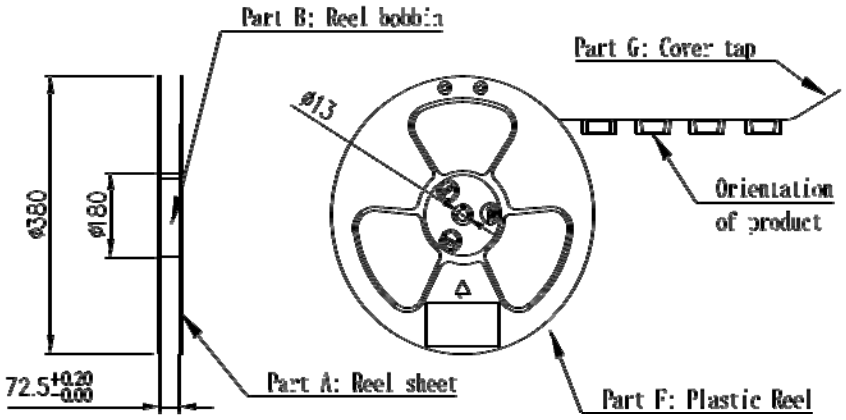


Figure 41: Reel Dimensions (Unit: mm)

Table 13: Reel Packaging

Model Name	MOQ for MP	Minimum Package: 200pcs	Minimum Package × 4=800pcs
SC200L	200	Size: 405 mm × 390 mm × 83 mm N.W: TBD G.W: TBD	Size: 425 mm × 358 mm × 410 mm N.W: TBD G.W: TBD

9 Appendix A References

Table 14: Related Documents

SN	Document Name	Remark
[1]	Quectel_Smart_EVB_G2_User_Guide	Smart EVB G2 user guide
[2]	Quectel_SC200L_Reference_Design	SC200L reference design
[3]	Quectel_SC200L_GPIO_Configuration	SC200L GPIO Configuration
[4]	Quectel_RF_Layout_Application_Note	RF layout application note
[5]	Quectel_Module_Secondary_SMT_User_Guide	Module secondary SMT user guide

Table 15: Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
AMR	Adaptive Multi-rate
AP	Access Point
bps	Bits per Second
CS	Coding Scheme
CSD	Circuit Switched Data
CSI	Camera Serial Interface
CTS	Clear to Send
DC	Dual Carrier
DRX	Discontinuous Reception
DSI	Display Serial Interface

DSP	Digital Signal Processor
EDGE	Enhanced Data Rate for GSM Evolution
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
ESD	Electrostatic Discharge
ESR	Equivalent Series Resistance
FDD	Frequency Division Duplex
FR	Full Rate
GMSK	Gaussian Minimum Shift Keying
GNSS	Global Navigation Satellite System
GPIO	General Purpose Input/Output
GPRS	General Packet Radio Service
GPS	Global Positioning System
GPU	Graphics Processing Unit
GRFC	Generic RF control
GSM	Global System for Mobile Communications
HR	Half Rate
HSDPA	High Speed Downlink Packet Access
HSPA	High Speed Packet Access
HSPA+	High-Speed Packet Access+
HSUPA	High Speed Uplink Packet Access
IC	Integrated Circuit
I/O	Input/Output
I2C	Inter-Integrated Circuit
Imax	Maximum Load Current

Inorm	Normal Current
LCC	Leadless Chip Carrier
LCD	Liquid Crystal Display
LCM	LCD Module
LDO	Low Dropout Regulator
LE	Low Energy
LED	Light Emitting Diode
LGA	Land Grid Array
LNA	Low Noise Amplifier
LTE	Long-Term Evolution
MIPI	Mobile Industry Processor Interface
NFC	Near Field Communication
NTC	Negative Temperature Coefficient
OTP	One Time Programable
PCB	Printed Circuit Board
PDU	Protocol Data Unit
PWM	Pulse Width Modulation
PSK	Phase Shift Keying
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RTC	Real Time Clock
RTS	Request to Send
Rx	Receive
SAW	Surface Acoustic Wave

SD Card	Secure Digital Card
SMS	Short Message Service
SPI	Serial Peripheral Interface
TDD	Time-Division Duplex
TP	Touch Panel
TVS	Transient Voltage Suppressor
Tx	Transmit
UART	Universal Asynchronous Receiver & Transmitter
UMTS	Universal Mobile Teleco mmunications System
USB	Universal Serial Bus
(U)SIM	(Universal) Subscriber Identity Module
VBAT	Voltage at Battery (Pin)
Vmax	Maximum Voltage Value
Vnorm	Normal Voltage Value
Vmin	Minimum Voltage Value
V_I	Voltage Input
$V_{IH}max$	Maximum Input High Level Voltage Value
$V_{IH}min$	Minimum Input High Level Voltage Value
$V_{IL}max$	Maximum Input Low Level Voltage Value
$V_{IL}min$	Minimum Input Low Level Voltage Value
V_Imax	Absolute Maximum Input Voltage Value
V_Imin	Absolute Minimum Input Voltage Value
V_O	Voltage Output
$V_{OH}max$	Maximum Output High Level Voltage Value
$V_{OH}min$	Minimum Output High Level Voltage Value

V_{OL}max	Maximum Output Low Level Voltage Value
V_{OL}min	Minimum Output Low Level Voltage Value
WCDMA	Wideband Code Division Multiple Access
WLAN	Wireless Local Area Network

10 Appendix B GPRS Coding Schemes

Table 16: Description of Different Coding Schemes

Scheme	CS-1	CS-2	CS-3	CS-4
Code Rate	1/2	2/3	3/4	1
USF	3	3	3	3
Pre-coded USF	3	6	6	12
Radio Block excl. USF and BCS	181	268	312	428
BCS	40	16	16	16
Tail	4	4	4	–
Coded Bits	456	588	676	456
Punctured Bits	0	132	220	–
Data Rate Kb/s	9.05	13.4	15.6	21.4

11 Appendix C GPRS Multi-slot Classes

Twenty-nine classes of GPRS multi-slot modes are defined for MS in GPRS specification. Multi-slot classes are product dependent, and determine the maximum achievable data rates in both the uplink and downlink directions. Written as 3+1 or 2+2, the first number indicates the amount of downlink timeslots, while the second number indicates the amount of uplink timeslots. The active slots determine the total number of slots the GPRS device can use simultaneously for both uplink and downlink communications.

The description of different multi-slot classes is shown in the following table.

Table 17: GPRS Multi-slot Classes

Multislot Class	Downlink Slots	Uplink Slots	Active Slots
1	1	1	2
2	2	1	3
3	2	2	3
4	3	1	4
5	2	2	4
6	3	2	4
7	3	3	4
8	4	1	5
9	3	2	5
10	4	2	5
11	4	3	5
12	4	4	5
13	3	3	NA
14	4	4	NA

15	5	5	NA
16	6	6	NA
17	7	7	NA
18	8	8	NA
19	6	2	NA
20	6	3	NA
21	6	4	NA
22	6	4	NA
23	6	6	NA
24	8	2	NA
25	8	3	NA
26	8	4	NA
27	8	4	NA
28	8	6	NA
29	8	8	NA
30	5	1	6
31	5	2	6
32	5	3	6
33	5	4	6

12 Appendix D EDGE Modulation and Coding Schemes

Table 18: EDGE Modulation and Coding Schemes

Coding Scheme	Modulation	Coding Family	1 Timeslot	2 Timeslot	4 Timeslot
MCS-1	GMSK	C	8.80 kbps	17.60 kbps	35.20 kbps
MCS-2	GMSK	B	11.2 kbps	22.4 kbps	44.8 kbps
MCS-3	GMSK	A	14.8 kbps	29.6 kbps	59.2 kbps
MCS-4	GMSK	C	17.6 kbps	35.2 kbps	70.4 kbps
MCS-5	8-PSK	B	22.4 kbps	44.8 kbps	89.6 kbps
MCS-6	8-PSK	A	29.6 kbps	59.2 kbps	118.4 kbps
MCS-7	8-PSK	B	44.8 kbps	89.6 kbps	179.2 kbps
MCS-8	8-PSK	A	54.4 kbps	108.8 kbps	217.6 kbps
MCS-9	8-PSK	A	59.2 kbps	118.4 kbps	236.8 kbps

FCC Certification Requirements.

According to the definition of mobile and fixed device is described in Part 2.1091(b), this device is a mobile device.

And the following conditions must be met:

1. This Modular Approval is limited to OEM installation for mobile and fixed applications only. The antenna installation and operating configurations of this transmitter, including any applicable source-based time-averaging duty factor, antenna gain and cable loss must satisfy MPE categorical Exclusion Requirements of 2.1091.

2. The EUT is a mobile device; maintain at least a 20 cm separation between the EUT and the user's body and must not transmit simultaneously with any other antenna or transmitter.

3.A label with the following statements must be attached to the host end product: This device contains FCC ID: XMR2021SC200LEM.

4.To comply with FCC regulations limiting both maximum RF output power and human exposure to RF radiation, maximum antenna gain (including cable loss) must not exceed:

- ❒ GSM850 :≤8.446 dBi
- ❒ GSM1900 :≤10.03dBi
- ❒ WCDMA Band II/ LTE Band2/ LTE Band7/ LTE Band38/ LTE Band41 : ≤9.416 dBi
- ❒ WCDMA Band V/ LTE Band5 ≤8.000dBi

5. This module must not transmit simultaneously with any other antenna or transmitter

6. The host end product must include a user manual that clearly defines operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines.

For portable devices, in addition to the conditions 3 through 6 described above, a separate approval is required to satisfy the SAR requirements of FCC Part 2.1093

If the device is used for other equipment that separate approval is required for all other operating configurations, including portable configurations with respect to 2.1093 and different antenna configurations.

For this device, OEM integrators must be provided with labeling instructions of finished products. Please refer to KDB784748 D01 v07, section 8. Page 6/7 last two paragraphs:

A certified modular has the option to use a permanently affixed label, or an electronic label. For a permanently affixed label, the module must be labeled with an FCC ID - Section 2.926 (see 2.2 Certification (labeling requirements) above). The OEM manual must provide clear instructions explaining to the OEM the labeling requirements, options and OEM user manual instructions that are required (see next paragraph).

For a host using a certified modular with a standard fixed label, if (1) the module's FCC ID is not visible when installed in the host, or (2) if the host is marketed so that end users do not have straightforward commonly used methods for access to remove the module so that the FCC ID of the module is visible; then an additional permanent label referring to the enclosed module:"Contains Transmitter Module FCC ID: XMR2021SC200LEM" or "Contains FCC ID: XMR2021SC200LEM" must be used. The host OEM user manual must also contain clear instructions on how end users can find and/or access the module and the FCC ID.

The final host / module combination may also need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.

The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. In cases where the manual is provided only in a form other than paper, such as on a computer disk or over the Internet, the information required by this section may be included in the manual in that alternative form, provided the user can reasonably be expected to have the capability to access information in that form.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.